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Editor, Bernard V. Gutsell, Geographical Branch, Department of Mines and Technical Surveys, Ottawa.

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Rédacteur: Bernard V. Gutsell, Direction de la géographie, ministère des Mines et des Relevés techniques, Ottawa.

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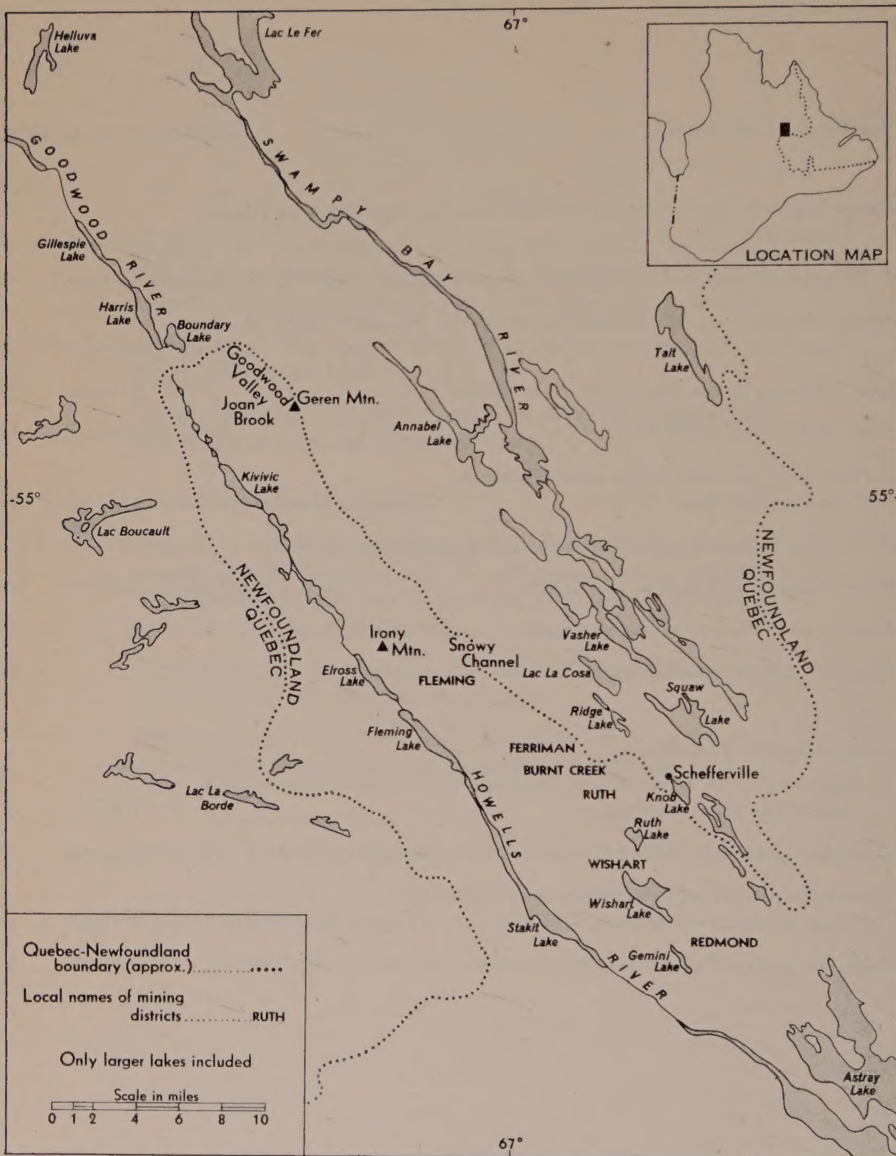

Figure 1. Location map, central Labrador-Ungava.

Carte repère, partie centrale du Labrador-Ungava.

DEGLACIATION IN CENTRAL LABRADOR-UNGAVA AS INTERPRETED FROM GLACIAL DEPOSITS

*R. P. Kirby**

ABSTRACT: The final dissolution of ice in Labrador-Ungava is now commonly regarded as having been in the vicinity of Schefferville. This paper presents some of the results of a study of the form and origin of glacial deposits in the Schefferville area, and is complementary to earlier studies of the glacial erosional features. The work involved detailed mapping of the glacial morphology and study of the fabric and composition of the deposits.

The ground moraine reveals evidence of the last regional ice movement, which was from the north-northwest across Schefferville, although glacial striations provide evidence of earlier movements from other directions. After weakening and cessation of ice movement, hummocky moraine forms and glacio-fluvial material were laid down. This represents the final phase of deglaciation when the continental ice has become climatically dead. It disintegrated rapidly in situ with the final pieces melting on the floors of the larger depressions north of Schefferville.

The final dissolution of ice in the Labrador-Ungava peninsula at the end of the Pleistocene glaciation is now commonly regarded as having been in the vicinity of Schefferville close to the geographic centre of this great land mass (Ives, 1960). During 1958 and 1959, a study was made of the form and origin of glacial deposits in this region in order to obtain further correlative evidence of the deglaciation.

A study of glacial deposits alone cannot provide a complete explanation of the recession and wasting of the continental ice in this area; the glacial erosional features, and especially glacial drainage channels are at least of equal importance. But in the case of central Labrador-Ungava, there already exist quite detailed studies of glacial drainage channels (Ives, 1959; Derbyshire, 1960), and it is on these studies and the work of Henderson (1956, 1959) that knowledge of the deglaciation has been based. This paper is therefore a complementary study to those on the glacial drainage channels, and is an alternative statement to that of Henderson.

The working area extended from Gillespie Lake (55°10'N) in the north to Gemini Lake (54°40'N) near Redmond in the south (Figure 1). Apart from the district around and immediately east of Schefferville townsite, examination was confined to the hilly belt west of the townsite.

* The author completed the field research while a member of the McGill Sub-Arctic Research Laboratory, 1958-59. The resulting study was presented to the Geography Department at McGill University as a M. Sc. thesis. Mr. Kirby is now a member of staff of the Geography Department of the University of Edinburgh, Scotland.

MS. submitted January, 1961.

It is in this area that high-grade iron ore is mined by open-pit methods by the Iron Ore Company of Canada, and it is the large quarries and many hundreds of exploration trenches dug by this company, as well as the numerous good natural exposures, that has made possible the study, not only of surface form, but also of the internal structure and composition of many glacial drift features.

THE PHYSICAL BACKGROUND

The Schefferville area is within the Labrador Trough, an extensive belt of Proterozoic rocks, mainly of sedimentary origin but much folded and thrust-faulted by pressure from the northeast. Strike outcrops of resistant quartzite, dolomite and slates form elongate ridges, while iron-formation and less resistant slates and dolomites underlie the valleys. The marked parallelism of ridges and valleys is the most dominant feature of the landscape, giving ease of movement along the strike outcrops northwest to southeast, but often considerable difficulty of movement transverse to the grain in an east-west direction. Local relief is usually less than 600 feet and more frequently 300–400 feet, but the higher ridges are often steep-sided and closely spaced so that the visual effect of relief is exaggerated. The resistant formations may rise, in an extreme instance, as much as 1,200 feet above the lowest lakes.

The hilly belt west of Schefferville townsite is about 5 miles wide, bounded on the east by the lake-studded Schefferville depression at a height of 1,550–1,650 feet, and on the west by the narrower depression of the Howells River valley at the same altitude. The hilly belt is mostly underlain by quartzites and dolomites with thinner outcrops of slate and iron-formation. Differential erosion on these lithologies has produced stretches of open, undulating country, interspersed by areas of miniature scarp-and-vale topography. There is a broad upper surface between 2,000 and 2,400 feet, but this is not obviously an erosion surface and hardly regular enough to be called a plateau.

Schefferville is not only near the geographical centre of Labrador-Ungava, being roughly 250 miles from tidewater in Ungava Bay and the Atlantic, and 350 miles from the Gulf of St. Lawrence and Hudson Bay, but also near the present drainage basin divide between the Atlantic and Arctic systems, perhaps decisive factors in determining the site of the last remaining parts of the original Labrador ice sheet. The watershed between Atlantic and Arctic drainage, corresponding also to the boundary

between the political units of Quebec and the coast of Labrador, follows a tortuous line across both the Schefferville depression and the hilly belt (Figure 1). Knob Lake is practically on the height of land, draining northwards through the Kaniapiskau-Koksoak system to Ungava Bay. The Howells River and lakes in the Schefferville depression south of Knob Lake drain southeastwards through the Ashuanipi-Hamilton system to the Atlantic. There are areas of indeterminate drainage on the flatter parts of the hilly belt where the watershed is not at all clearly defined.

The deranged drainage pattern owes its irregularity in part to the cover of drift deposited as a result of the Pleistocene glaciations. On the hilly belt, the drift is usually too thin and the slopes too steep to cause more than insignificant drainage diversions; the many glacial drainage channels run along rather than down the slopes, and so have seldom been utilized as stream courses. But on the flat-floored Schefferville depression, where the drift cover is almost continuous and much thicker than on the higher ground, streams have been diverted from their pre-glacial courses, and shallow drift-controlled lakes have been formed. However, most of the lakes are deep and bedrock-controlled. Bedrock is exposed at the surface over perhaps 10 per cent of the region, mainly on ridge tops, along steep valley sides, and on the shores of some of the larger lakes.

DRIFT COVER

The most obvious characteristics of the drift cover are heterogeneity of form, great variations in thickness and general piecemeal occurrence. Of the forms composed of till, there is, broadly speaking, a natural twofold distinction between featureless ground moraine and hummocky forms of moraine. It is especially hard to produce a genetic classification of the hummocky forms, because they are too thinly scattered to be easily mappable and, in any case, appear to grade one form into another. The forms known collectively as ice-contact stratified drift (Flint, 1957) are subordinate in amount to the till and are of very variable appearance.

The most widespread type of drift is till, forming a blanket of ground moraine. This blanket is usually quite thin but altogether absent only where bedrock outcrops or, locally, where another form of drift predominates. The ground moraine is usually featureless and seldom thick enough to mask more than the smaller irregularities of the underlying bedrock surface. The rather meaningless figure for average depth of till is between 2 and 4 feet. Depth of till increases in confined valleys and also at the

base of hillslopes, perhaps from one foot to many feet within a few paces. The greatest depth of undisturbed till measured was 25 feet in a structural depression on a hillslope at Redmond. Small remnant patches of till and also erratic boulders occur on many hilltops that are otherwise bare and, irrespective of altitudes, rounded ridge tops carry deep till whereas steeper and sharper ridges are almost bare. There is thus no doubt that till was initially deposited over-all; its present distribution reflects on the steepness of the slopes and the stability of the material after deposition on these slopes.

At Vasher Lake, an exposure shows $1\frac{1}{2}$ feet of light-colored sandy till overlying $2\frac{1}{2}$ feet of darker more compact till without preferred fabric orientation. At Ruth Lake excavation, in a continuous exposure of 1,100 feet, between 8 inches and 3 feet of coarse unconsolidated till, with inclusions of bedded sands and a high proportion of pebbles and boulders, overlies a darker more compact till $1\frac{1}{2}$ to $4\frac{1}{2}$ feet thick, with marked absence of pebbles and boulders (Figure 2). In this instance, the lower till has a preferred fabric orientation that identifies it as the product of the latest regional ice movement in the area, which was from the north-northwest; therefore the coarser till above represents a later deposition, under conditions of melting ice, from the same ice sheet.

From the many hundred exposures examined, these two sections showed the only examples from ground moraine of what could be described as ablation till, although erratic boulders of all sizes lying on till may represent a very dispersed ablation load.

The normal featureless moraine is occasionally replaced by hummocky ground moraine which usually appears as a complex of hillocks and hollows apparently without form. At Ferriman, 200 feet below the summit of a quartzite ridge on its east slope, the moraine for 1,000 feet along the slope is in flat-topped mounds of varying size, sometimes inter-connected and sometimes separate, with steep or gently sloping sides as high as 10 feet from crest to hollow, and with as much as 6 feet more of till below this. Particle size analyses at this and other sites (Figure 3) indicate that the till has the same proportions of clay and silt as other ground moraine material, suggesting it has not suffered an abnormal amount of water-washing. The irregularity of topographic form, best appreciated from aerial photographs, suggests it is dead-ice moraine, deposited from stagnant ice.

Figure 2

Coarse rubbly till with sand lens inclusion overlying finer till.

Till grossier et rocailleux comprenant des lentilles de sable et recouvrant un till plus fin.

Figure 3

18-particle size analyses from till. The plain dots indicate analyses from featureless ground moraine; the circled dots, analyses from hummocks and hummocky ground moraine. By comparison, analyses from glacio-fluvial deposits would show over 98% sand and gravel. Sides of diagram divided into 10% intervals.

18 analyses granulométriques du till. Les points ordinaires indiquent des analyses de moraine de fond n'ayant aucune particularité. Les points encerclés indiquent des analyses de bosses et de moraine de fond bosselée. Par contre, les analyses des dépôts fluvioglaciaires révèlent la présence d'au-delà de 98 p. 100 de sable et de gravier. Les côtés du diagramme sont divisés en parties égales chacune équivalant à 10 p. 100.

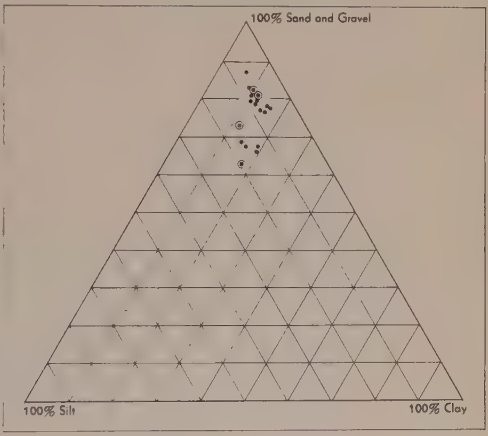

Figure 4

Typical hummock composed of till on the floor of a minor valley. Ferriman area, elevation 2,450 feet.

Bosse typique formée de till reposant au fond d'une vallée secondaire. Région de Ferriman, altitude: 750 m.

Hummocky ground moraine with less relief than at Ferriman has been noted on several higher areas where the till cover is deeper than normal. For example, the large saucer-shaped Fleming depression west of Snowy Channel is blanketed by thick, occasionally hummocky, ground moraine. Five elongate hummocks in this basin, the largest 400 feet long, 70 feet wide and a maximum of 15 feet high, are aligned parallel roughly north-northwest. Such deposits, revealing the influence of former ice-sheet movement, have been called 'controlled' deposits by Gravenor and Kupsch (1959). Because north-northwest is close to the strike direction of the bedrock, it is hard in other cases to distinguish between strike-controlled, bedrock-cored features and glacier-controlled depositional forms.

Distinct from hummocky ground moraine are those hummock features, isolated or grouped, that rest on a surface of bedrock or ground moraine, and hence would seem to have been deposited later than the moraine. These features vary considerably in size and shape and are here referred to as 'hummocks'.

The individual hummocks found on the floors and sides of valleys generally have horizontal tops, are steep-sided and elongate downslope to a degree dependant upon the declivity (Figures 4 and 5). The lower end is frequently as steep as 60° for 3 to 4 feet at the base with active solifluction promoting the downhill extension still farther. Two hummocks, including the one illustrated in Figure 5, were seen to show depressions 1 to 2 feet deep at their centres. This 'doughnut' effect has been remarked upon by Gravenor (1955) who attributes the general forms to slow wastage of stagnant ice covered by debris-filled hollows.

Hummocks on more open ground are less numerous but as well developed as those in valleys. The best examples are found grouped in strings, and occur in the area north of Joan Brook and in the Fleming area. At Fleming, a string of 14 hummocks is aligned N35°W along the line of a broad flat col. The individual hummocks are oval in plan, flat-topped and steep-sided. The largest members are in the centre of the line, 50 to 200 feet long and 30 to 100 feet wide with an average height of 12 feet. The end members of the line are only 5 feet high and 20 feet long although still preserving fairly steep sides.

The material of these hummocks, as well as that of all the other hummocks examined, is till, indistinguishable in the field or in the laboratory from the till of adjacent ground moraine (Figure 3). Laboratory checks also indicate that pebbles within the till are angular and subangular, and

also striated in the proportions normal to ground moraine; in none of the sections exposed in hummocks is there any suggestion of washed sand or of fluvial bedding. Till fabric analysis of one hummock showed completely random orientation of particles.

The composition of the isolated hummocks and strings of hummocks as described above makes it impossible to describe them as kames. In general, however, subglacial deposition is favored for their origin, either as englacial material let down in the melting-out of the ice, or as sub-glacial crevasse fillings, possibly concentrated into basal cavities through squeezing in the manner suggested by Hoppe (1952). The line of hummocks at Fleming is no more than 50 feet above the lowest point across the col, suggesting a sub-glacial origin as most likely. A similar line of six hummocks on the shallow slope south of Snowy Channel is aligned downslope and flanked on one side by a sub-glacial drainage channel, evidence that suggests particularly a sub-glacial rather than an ice-marginal mode of formation.

Without referring to any particular examples, Henderson (1959, p. 35) considers that the smaller mounds (i.e. hummocks) "were laid by local drainage in shallow ponds in thin ice", a view not supported by their internal constitution of unsorted till, described above. He suggests that the hummocks 10 to 15 feet high "may have been built largely by the slumping of till into depressions in stagnant moraine-covered ice", a similar explanation to that offered by Gravenor (1955). Henderson hesitates to call the larger mounds kames as he too finds they are largely composed of gravelly till.

Small-scale examples of kettle topography occur in pockets of deeper drift throughout the area. In the hilly belt, either single or groups of steep-sided kettles are common in bedrock-enclosed areas of deep moraine (Figure 6). The kettles are usually circular or oval in outline, often 100 to 200 feet in diameter and typically about 20 feet deep. They are often filled with water, either as permanent lakes or as seasonal meltwater. Other examples were noted in the Schefferville depression, inevitably in low-lying swampy ground with a thick vegetation cover.

Although the dominant glacial deposits are composed of till, there are subordinate amounts of stratified or glacio-fluvial drift. Because some well-washed deposits are not visibly stratified, in the sense of having alternate layers of different composition, the designation 'stratified drift'

Figure 5

Hummock composed of till on side of a minor valley. Joan Brook area, elevation 2,400 feet.

Bosse formée de till sur le versant d'une vallée secondaire. Région du ruisseau Joan, altitude: 750 m.

Figure 6

Kettle topography in deep drift. Bedrock ridges on right and left of picture. Ferriman area, elevation 2,400 feet.

Marmites glaciaires dans une épaisse couverture de débris morainiques. Crêtes façonnées dans la roche en place, à la droite et à la gauche de la photo. Région de Ferriman, altitude: 730 m.

is employed in this study only as a descriptive term and 'glacio-fluvial deposit' is retained as the term for all accumulations of drift on which the effect of water-washing is visible.

The total amount of glacio-fluvial deposits in the Schefferville area is slight and the distribution patchy. Considering the abundance of glacial drainage channels, this small amount of glacio-fluvial material is perhaps surprising, but may be explained by the initial lack of till, from which most of the water-washed deposits will have been derived.

In practice, the composition of water-washed deposits was found to range widely, from the extremely coarse rubbly deposits found at Burnt Creek and at Wishart to quite homogeneous gravelly beds such as within Schefferville townsite. Between these extremes occur the more typical deposits, mainly coarse-bedded sands, gravels and cobbles with occasional thin sand beds lacking any coarser material.

The typical location site for glacio-fluvial deposits is at the base of slopes and at the edge of depressions below about 2,000 feet altitude, where they form broad sheets probably in all cases overlying till. It appears that debris, carried by running water down the hill slope beside and beneath melting ice, mixes with released englacial material, and the two are water-sorted into crude bedding. Beds may combine or thin out and terminate very abruptly, and often dip at several degrees. Most of the load is dropped near the base of the slope as the momentum of the running water is checked; the glacio-fluvial sheet is always thickest at the edge and thins away from the edge of low ground.

A common variant of this featureless sheet-type of glacio-fluvial drift is a hummocky sheet form, as found for example on the west side of Star Lake (Figure 7). Here, a till layer 2 to 4 feet thick on a 5° slope down to the lake, is overlain by a cover 1 to 2 feet thick of well-bedded sands and gravels, broken up by linear and circular hummocks irregularly scattered up and down the slope, the latter also composed of glacio-fluvial material and notable for occasional thick lenses of fine sand.

Hummocks of stratified drift on moderately steep slopes can only have developed such delicate bedding if there were some restraining medium to prevent the sands being washed away down the slope; this medium is thought to have been the ice-walls of an overlying mass of immobile ice, the hummocks being formed in cavities at the base of the ice. Glacio-fluvial hummocks have been noted on slopes as steep as 10° where they are aligned downslope.

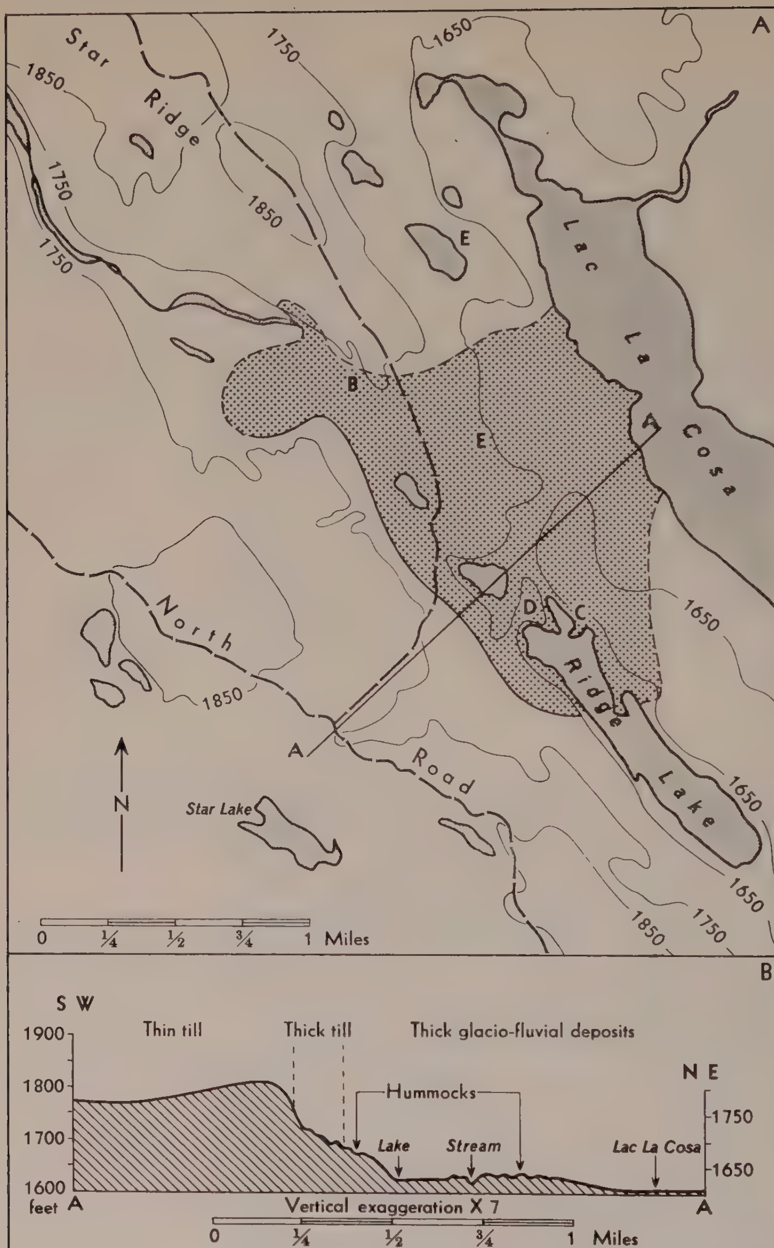

Figure 7. The distribution of glacial deposits near Ridge Lake. In Figure 7A, the stippled area indicates glacio-fluvial deposits. AA is the section line of Figure 7B. Other letters are referred to in the text.

Distribution des dépôts glaciaires aux environs du lac Ridge. Sur la figure 7A, la région pointillée indique des dépôts fluvio-glaciaires. AA: ligne de coupe de la figure 7B. L'auteur réfère aux autres lettres dans le texte.

Glacio-fluvial deposits are also found characteristically in closed depressions, often around and beneath small kettles indicating former small blocks of stagnant ice. The floors of most glacial drainage channels are either bare or covered at most with a few inches of till; a few, however, have some depth of bedded material on their floors or occasionally at their lower outlet ends.

Textual Gradation of Drift

It has been remarked that the degree of stratification between glacio-fluvial deposits of different forms may vary greatly. It is also true that there exists a gradation in texture and degree of stratification within deposits of the same form. More specifically, there may exist a gradual and continual change in coarseness or degree of water-washing between two points, from normal till with 20 per cent silt and clay through unbedded sandy till to bedded sandy glacio-fluvial deposits with only 2 per cent of silt and clay. This change takes place downslope.

To follow this transformation easily in the field required a large hillside area with many exposures closely spaced. This is not likely to occur naturally and only at two suitable locations were there sufficient man-made trenches.

The first example of this textural gradation was found across the North Road, 8 miles N55°W of Schefferville at a height of 1,850 feet. On the ground there is only a very shallow channel sloping at a low angle due north diagonally down the hillside. On approaching this channel from either side, the till, which is several feet deep, gradually becomes over a distance of 500 feet much more sandy although apparently without stratification. On following the floor of the channel downslope, the till increases in coarseness, becomes hummocky and eventually well-bedded.

Meltwater runoff must be responsible for this reduction of the fines content in the till. As the volume of water increases downhill, particle sorting increases and fluvial bedding develops.

The second location at the northwest end of Ridge Lake on the edge of the hilly belt is far more extensive than the first (Figures 7 and 8). The sediment gradation is not limited to a narrow belt centred on a channel, but can be seen across the entire width of the hillside. The drift succession from southwest to northeast down from the higher ground, across the north end of Ridge Lake to Lac La Cosa, is illustrated in Figure 7B. The till cover is thin at 1,800 feet, has increased in thickness at 1,750 feet and

gradually becomes coarser. At 1,700 feet, there is a fairly abrupt change of composition from coarse till to poorly bedded, rubbly glacio-fluvial deposit. This is not reflected by any corresponding change in the surface form, by now slightly hummocky. Farther along the hillside, the change occurs at 1,750 feet, corresponding with a break of slope. At the base of the hillside on level ground, the glacio-fluvial deposits are characteristically hummocky (Figure 8); this must be accounted for in terms of deposition in contact with stagnant ice, because proglacial stratified drift is normally deposited in thin, flat, courses of foreset beds without topographic relief. The glacio-fluvial hummocks (kames) average 20 feet in diameter; the larger ones may be as much as 10 feet high between crest and hollow. No steep-sided circular cavities were found, such as are sometimes left by the melting of small blocks of stagnant ice.

The glacio-fluvial features increase in size and thickness on the low ground to give almost the appearance of an esker complex, but short sections of eskers, composed of sandy silt and of sand, occur only infrequently (Figure 7A; locations EE). Aerial photographs, however, reveal some over-all pattern in the ridges and knobs: at the north end of Ridge Lake they form a delta of classical shape (Figure 7A; location D) built by the glacial stream from the direction of Star Lake. Linear hummocks radiating from the apex of the delta indicate the beds of old sub-glacial distributaries. Sediment has also been brought into this area from the northwest along the valley south of Star Ridge (Figure 7A; location B) as shown by the lineated glacio-fluvial deposits here. It is clear that the finer material has been washed farthest out onto the low ground, for towards the west side of Lac La Cosa the deposits are in places almost one hundred per cent sand.

Around the base of Star Ridge, the downslope textural changes are more gradual than those described above for the other edges of the basin. Hummocky till is replaced by sandy stratified deposits over a broad area approximately along the line of the 1,750-foot contour.

The upslope limit of stratified drift is related to the availability of water for washing and sorting the particles. On steep slopes, as along section AA (Figure 7B), the change between stratified and unstratified drift is abrupt. The dividing line can be considered to be either the point at which the volume of meltwater running down the slope from overlying glacier ice has increased sufficiently to sort particles larger than sand; or, in certain other cases, as the upper limit of the side of a large block of ice

occupying the valley bottom. On shallow slopes, as at the south end of Star Ridge, the change is more gradual. The division here occurs on almost level ground that would have been completely beneath the ice at the time the drift was deposited.

One point seems to prove more conclusively the sub-glacial origin of the drift in this area. At the north end of Ridge Lake, a glacial drainage channel cuts across the ridge separating this lake from Lac La Cosa (Figure 7A; location C). The floor of the channel dips northeast, opening into a flat sandy area at a lower altitude, and the channel itself appears to mark a sub-glacial meltwater course from the area of Ridge Lake to the area of Lac La Cosa. The channel is unlikely to be a supra-glacial spillway because there are at least two lower outlets, one at each end, for the small basin now occupied by Ridge Lake. Linking up with the glacial drainage channel and partly submerged in the lake is an irregular linear ridge of sand, the top of which leads into the floor of the channel. This combination of features is not uncommon, a sub-glacially engorged esker leading from a sub-glacial drainage channel. Because the channel across the ridge cuts 20 feet deep, through 10 feet of sandy drift and 10 feet of bedrock, the drift was deposited earlier than the channel was cut and is therefor also sub-glacial in origin.

Interpretation of Features of Drift Cover

From the above description of drift forms, it is possible to make a partial summary of the events during the phases of glaciation when the deposits were laid down.

The thin ground moraine, of average composition 20 per cent silt and clay, and 80 per cent sand and gravel (Figure 3), is the only drift form to appear over at least three-quarters of the hilly belt. But to an increasing degree towards lower ground it is replaced or concealed by other forms. The ground moraine was deposited as the result of regional ice movement; other evidence, relating to striations and to till fabric analysis of the ground moraine (being presented in a separate paper on ice movements), indicates clearly that the ice movement in question was the last regional movement in the area. In the Schefferville district, this movement was from the north-northwest. Although in many places striations indicate at least two directions of regional ice movement, neither field investigation, till fabric analysis, nor particle size analysis suggests the existence of more than one till sheet.

Figure 8

Thick hummocky glacio-fluvial deposits at the north end of Ridge Lake, elevation 1,650 feet. Looking northeastwards.

Épais dépôts fluvio-glaciaires bosselés à l'extrémité nord du lac Ridge, altitude: 500 m. Vue vers le nord-est.

Figure 9

Middle section of the Goodwood Valley, looking east-southeast. The floor of this section of the valley is at about 2,050 feet elevation.

Partie centrale de la vallée Goodwood, vue en direction est-sud-est. Le fond de la vallée à cet endroit à une altitude approximative de 625 m.

There is little evidence from the drift, apart from the fabric of the ground moraine itself, of active ice movement. Drumlinization is completely absent; crag-and-tail features are uncommon; the only drift tail that was proved not to have a bedrock core and so proved to be a drift tail at all, is a small feature 20 feet long at the southern end of a quartzite knob at Wishart. Of the glacial erosional features, *roches moutonnées* are poorly developed and striations are usually shallow and faint. These factors taken in conjunction suggest that at no time was the regional ice movement very strong. But in contrast to the lack of evidence for active ice, there is a multiplicity of glacial drift features to indicate stagnant ice.

The hummocky ground moraine is representative of conditions at the time when the last regional ice movement had weakened and ceased, the forms being either 'controlled' or 'uncontrolled' (Gravenor and Kupsch, 1959), depending upon the influence of the previously active ice.

Individual hummocks and strings of hummocks overlie and therefore relate to somewhat later conditions than the ground moraine. Their distribution in both cases can be linked with the local topography. Isolated hummocks, and also kettles, are found at all altitudes in enclosed depressions where moraine and blocks of glacier ice have been trapped. Single hummocks also occasionally occur on higher open ground. Strings of hummocks have been found only where there is ample room for their development, on open ground above 2,250 feet, where they appear to have been deposited along crevasse lines in association with sub-glacial drainage.

Deposition of glacio-fluvial material is favored by high temperatures and little glacier movement, such as might prevail during deglaciation. In this area, the glacio-fluvial deposits are located in basins of deposition, especially at the edges of such basins, and in combination with glacial drainage channels. Derbyshire (1960) notes the sparsity of glacio-fluvial deposits at the surface and uses this fact, together with his evidence of considerable sub-glacial drainage, to support the hypothesis that during deglaciation, the ice sheet was immobile and rotted in situ. Certainly the glacio-fluvial deposits represent the final phase of melting when residual blocks of ice occupied the lower depressions, and the intervening ridges were already bare. The Schefferville depression is one such area where ice remained later than on the adjacent hills, as shown by the detailed evidence around Ridge Lake. Across the depression immediately northeast of Schefferville townsite, the drift is known to consist mainly of thin till;

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the townsite itself is on the edge of the depression and the lower part of the town is built on thick glacio-fluvial deposits similar to those around Ridge Lake.

The total absence of end moraines, such as might be expected in the larger valleys if there were any partial readvance of the ice sheet at the time of deglaciation, suggests that the ice margins at this time suffered a continual net regression. Any marked readvance would probably also have been illustrated by the destruction or modification of many of the glacial drainage channels.

However, end moraines have been described by Henderson (1959, pp. 23–26) in valleys at Geren Mountain (Figure 1) and, although this interpretation is not supported from the writer's personal knowledge of the Goodwood Valley adjacent to Geren Mountain (Figure 9), the presence or absence of end moraines is of such importance in discussing the deglaciation that the evidence must be considered in full.

Henderson proposes that the residual ice mass occupying the Howells-Goodwood Valley, with floor at 1,750 feet, drained for one period eastwards to the low ground around Swampy Bay Valley with its floor at 1,550 feet, by way of valleys across the dividing ridge (*see* Figure 1). Opposite Geren Mountain, the saddle between the valleys is at somewhat more than 2,450 feet, and is removed from the nearest point on the eastern lip of the Howells Valley (at 2,000 feet) by nearly 5 miles of rolling upland.

Henderson has identified end moraines on either side of the saddle. As there is no suitable firn area above the saddle that could provide a short ice tongue, the presence of end moraines at such a height requires ice below the saddle on one or both sides. Henderson suggests a tongue of ice in the Goodwood Valley at first overspilling the saddle and leaving end moraines to represent the successive lower limits of the ice tongue, and later retreating back over the saddle and leaving deposits on the western side in an ice-dammed lake to represent the successive upper limits of ice. No independent evidence is presented for the existence of a proglacial lake.

At an early period of ice wasting, Geren Mountain, adjacent ridge tops and the highest saddles might reasonably be expected to be among the first areas to emerge as nunataks. The ice margin would then ebb progressively on each side of the main ridge, and away from the saddle in question. Such a process as Henderson envisages would therefore require a rejuvenated flow of ice from the west up the Goodwood Valley. Uphill

flow of ice has been recorded in isolated instances, but only where the rise is small, and the elevation and thrust from behind is great; these conditions do not prevail in this area. There could be little thrust up the high and somewhat sinuous Goodwood Valley tributary.

With the gradual retreat of the ice margins from the sides of the Geren Mountain, it is likely that lateral and sub-lateral drainage channels have been formed, and that these have been identified as glacial readvance features. Kettles and various hummocky till forms have been noted in both the upper and middle sections of the Goodwood Valley, features similar to those seen in many other valleys in the district and taken as indicating ice retreat and stagnation, but not readvance.

The denial of end moraines in the locality north of Geren Mountain does not preclude their existence elsewhere in connection with the waning ice sheet, although no such moraine was found. The cyclical moraine pattern south of Dyke Lake, a few miles to the southeast of Schefferville, suggests periodic deposition either sub-glacially or proglacially but opinions still differ radically on the mode of formation of these deposits (Ives, 1956; Henderson, 1959).

ICE CONDITIONS FOLLOWING THE GLACIAL MAXIMUM

Weak regional ice movements in the Schefferville and Geren Mountain districts—which in themselves seem to indicate the proximity of the area to the regional ice divide—were followed by the final phase of deglaciation which can be recognized from the relative abundance and disposition of glacio-fluvial deposits and dead-ice forms characterized by stagnant ice downwasting in situ. Although great caution must be used in identifying an area of final ice stagnation solely on the dead-ice phenomena, nevertheless dead-ice forms appear to be more common in this area of the peninsula than towards the coasts. Kettles and hummocks occur on the higher ground in small closed depressions and in valleys, indicating ice remnants trapped when the main mass of thin and stagnant ice had begun to down-melt and break up into blocks separated by the major ridges. On more open ground, individual hummocks represent random deposition and lines of hummocks represent controlled deposition from sub-glacial meltwater. Lateral terraces have not been widely recognized; this points to ice margins too mobile to allow lateral deposits to build up, and rapid melting of the ice from at least the higher ground. Derbyshire (1959),

however, refers to a series of delta-like forms which 'hang' at varying heights on the east slope of the Howells Valley between Stakit Lake and Elross Lake. These appear to be lateral features of late glacial origin, related to the residual lobe of ice in the Howells Valley.

It is thought that the climate during the final period of deglaciation was similar to, or more mild than, the climate today (Manley, 1955; Ives, 1959), and that the ice retreat and downwasting proceeded quite rapidly (Derbyshire, 1959). In view of this, a suggestion of possible expansion of parts of the ice masses following a cooler period with fresh accumulation of snow (Henderson, 1959, p. 67) is not supported. To promote renewed movement of the small residual area of ice near the centre of the peninsula would require glacierization of much of the central plateau, and there does not seem to be any morphological evidence for this. There certainly would not appear to be a strong case for advocating a considerable climatic deterioration and glacial readvance in central Labrador-Ungava by analogy with an advance in the Alaska Coast Range (Henderson, 1959, p. 67) as the climatic and topographic conditions are completely different.

In summary, it appears that the continental ice in the Schefferville area became climatically dead at the stage when it still covered the entire surface, and melted down rapidly in situ with the highest ridges being first to protrude above its surface. As the ice surface lowered to reveal more and more of the ground beneath, the rate of ablation probably increased; meltwater flowed in many small streams under the ice, sorting and redistributing the drift. The ice in the deeper valleys was thicker than on adjacent high ground and so took correspondingly longer to melt away. The last pieces of ice were situated on the floors of the larger depressions, but correlation between these residuals is unlikely.

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LA DÉGLACIATION DU CENTRE DE LA PÉNINSULE DU LABRADOR INTERPRÉTÉE À PARTIR DES DÉPÔTS GLACIAIRES

*R. P. Kirby**

RÉSUMÉ : On s'accorde aujourd'hui à dire que la dernière phase de la déglaciation de la péninsule du Labrador s'est déroulée aux environs de Schefferville. La présente communication résulte d'une étude des formes et de l'origine des dépôts glaciaires de la région de Schefferville et se veut un complément à des études antérieures des formes d'érosion glaciaires. Le travail nécessita un relevé cartographique de la morphologie glaciaire ainsi qu'une étude de la texture et de la composition des dépôts.

La moraine de fond révèle des traces du dernier mouvement régional des glaces vers le sud-sud-est à travers Schefferville, bien que des stries indiquent des mouvements antérieurs en d'autres directions. L'immobilisation des glaces fut suivie de la déposition de moraines bosselées et de matériaux fluvio-glaciaires. Ces phénomènes caractérisent la phase finale de déglaciation alors que l'inlandsis devint inerte et fondit rapidement sur place; les derniers morceaux à disparaître occupaient les plus grandes des dépressions situées au nord de Schefferville.

On s'accorde aujourd'hui à dire que c'est dans la région où est maintenant située Schefferville, à peu près au centre de la péninsule du Labrador, que s'est déroulé le dernier épisode de la déglaciation de cette vaste contrée (Ives, 1960). Dans le but d'obtenir de plus amples renseignements au sujet de la déglaciation de cette région, une étude de la morphologie et des origines des dépôts glaciaires y fut effectuée au cours des années 1958 et 1959.

Le recul et la fusion sur place des glaces continentales en cette région ne sauraient s'expliquer adéquatement à la seule lumière d'une étude des dépôts glaciaires; les phénomènes d'érosion glaciaire et surtout les voies d'écoulement des eaux de fonte sont tout aussi importants à cet égard.

Or, les chenaux de drainage glaciaire du centre de la péninsule du Labrador ont déjà fait l'objet d'études fort détaillées (Ives, 1959; Derbyshire, 1960) et nos connaissances de la déglaciation se fondent sur ces études et sur celles de Henderson (1956, 1959).

La présente communication se veut donc un complément à ces études des chenaux de drainage glaciaire, en même temps qu'une contre-proposition à celle de Henderson.

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* L'auteur effectua les travaux sur le terrain de 1958 à 1959, alors qu'il était affecté au Laboratoire de recherches subarctiques de McGill. L'hiver suivant ces observations de terrain furent élaborées en une thèse de maîtrise ès sciences qu'il présenta au Département de géographie de l'Université McGill. Monsieur Kirby est maintenant membre du personnel du Département de géographie de l'Université d'Édimbourg.

Le secteur à l'étude se situe entre le lac Gillespie (55°10'N) et le lac Gemini (54°40'N) près de Redmond (figure 1). Des relevés ont été effectués dans le voisinage immédiat de Schefferville et à peu de distance à l'est, mais la majeure partie des travaux a porté sur la bande de collines située à l'ouest de cette ville. C'est ici que la *Iron Ore Company of Canada* exploite en découvert de riches gisements de minerai de fer. Grâce aux vastes carrières et aux centaines d'excavations pratiquées par cette compagnie et à la présence de multiples affleurements naturels on a pu dépasser les limites du superficiel pour étudier en outre la structure même et la composition des nombreux dépôts de transport glaciaire.

LE CADRE PHYSIQUE

La région de Schefferville est située dans la Fosse du Labrador, laquelle forme une longue bande de roches d'âge protérozoïque d'origine principalement sédimentaire qu'une poussée du nord-est a plissée et découpée de failles de charriage. Le relief de cette contrée, fonction de la dureté des roches juxtaposées en rubans parallèles orientées vers le nord-ouest, s'apparente au type appalachien: aux têtes de couches de quartzite, de dolomie et d'ardoise correspondent les arêtes tandis que les vallées correspondent aux couches de minerai de fer et à celles d'ardoise et de dolomie de moindre dureté. Le parallélisme des crêtes et des vallées est le trait le plus caractéristique du paysage de cette région, au point de gêner considérablement tout déplacement perpendiculaire aux rides structurales. Le relief ne dépasse guère les 200 m et se maintient plutôt entre 100 et 125 m; toutefois, la raideur des pentes et la proximité des arêtes plus élevées peuvent laisser de la vigueur du relief une impression exagérée. La crête de certains dépôts d'une dureté exceptionnelle s'élève quelquefois jusqu'à 400 m au-dessus du niveau des plus bas lacs.

La bande de collines située à l'ouest de Schefferville mesure environ 8 kilomètres de largeur; elle est bornée à l'est par la dépression de Schefferville, une cuvette parsemée de lacs dont l'altitude est d'environ 550 m, et à l'ouest par la vallée Howells, une dépression plus étroite mais d'égale altitude. La roche en place consiste en quartzites et dolomies avec des affleurements d'ardoise et de roches ferrugineuses. L'érosion sélective a sculpté sur ces formations une plaine ondulée marquée en certains endroits d'un relief miniature de type appalachien. On rencontre un relief subhorizontal à environ 800 m d'altitude: trop irrégulière pour un plateau, cette zone ne saurait non plus être qualifiée d'ancienne surface d'érosion.

Située à quelque 150 kilomètres de la baie d'Ungava et du littoral de l'Atlantique, et à 220 kilomètres du golfe Saint-Laurent et de la baie d'Hudson, Schefferville, en plus d'être près du centre géographique de la péninsule du Labrador, est ainsi à peu de distance de la ligne actuelle de partage entre les eaux du réseau atlantique et celles du réseau arctique, et il se peut que ces facteurs aient contribué à fixer le site des derniers morceaux de l'inlandsis du Labrador. La ligne de partage entre les eaux de l'Atlantique et celles de l'Arctique, qui marque la frontière entre le Québec et le Labrador, traverse de son tracé tortueux et la dépression de Schefferville et la bande de collines (figure 1). Le lac Knob se trouve presque à chevaucher la ligne de partage des eaux et se déverse dans la baie d'Ungava par voie du système Kaniapiskau-Koksoak. La rivière Howells et les lacs de la dépression de Schefferville, au sud du lac Knob, se déversent dans l'Atlantique par voie du système Ashuanipi-Hamilton. Dans les endroits moins accidentés de la bande de collines, la ligne de partage des eaux est excessivement difficile à retracer.

L'irrégularité du réseau hydrographique est attribuable, en partie, aux désordres provoqués par les glaciers du Pleistocène. Sur la bande de collines, cette irrégularité est moins prononcée, étant donné le peu d'épaisseur des dépôts glaciaires et la raideur des pentes; les nombreux chenaux de drainage glaciaire sont parallèles aux crêtes et, de la sorte, n'ont pu servir d'artères fluviales. Mais dans la dépression de Schefferville, où le manteau de débris morainiques est presque continu et beaucoup plus épais que sur les hauteurs voisines, les cours d'eaux ont été détournés de leurs lits pré-glaciaires et des lacs de barrage glaciaire peu profonds se sont formés. Toutefois, la plupart des lacs sont profonds et controllés par la topographie de la roche en place. La roche en place affleure sur à peu près 10 p. 100 de la surface du territoire, principalement sur les crêtes, sur les versants escarpés des vallées et sur les rives de quelques-uns des plus grands lacs.

LES DÉPÔTS MORAINIQUES

Les traits les plus saillants du manteau de débris morainiques sont l'hétérogénéité des formes, les grandes différences d'épaisseur et la discontinuité. On peut partager les dépôts morainiques en deux grandes catégories: les moraines de fond, dépourvues de relief, et les moraines bosselées. La rareté et l'éparpillement des dépôts morainiques bosselés rendent ceux-ci difficiles à cartographier. De ce fait, il est quasi impossible d'en établir un classement qui tienne compte des origines. D'ailleurs, la distinction entre

ces deux formes de moraine n'est pas toujours très nette. Les dépôts morainiques stratifiés dits «de contact» (Flint, 1957) sont relativement peu nombreux et d'aspect très variable. Le type de dépôt morainique le plus répandu est le till dont est formée la moraine de fond. Ce manteau de till quoique plutôt mince recouvre tout le terrain, sauf les affleurements de roche en place et les quelques endroits où l'on trouve un autre genre de dépôt morainique. La moraine de fond est d'ordinaire dépourvue de relief et trop mince pour masquer complètement les aspérités de la roche en place qu'elle recouvre. L'épaisseur moyenne du till, si on peut parler d'épaisseur «moyenne», est d'environ 1 m. L'épaisseur de la moraine de fond va en augmentant dans les vallées étroites de même qu'au pied des versants et peut, sur une distance de quelques pieds, passer de 30 cm à 1,50 m. C'est à Redmond, dans une fosse tectonique sur un versant, qu'on a trouvé la plus grande épaisseur de till, à savoir 7,80 m. On trouve des vestiges de moraine de fond et des blocs erratiques au sommet de plusieurs collines et l'épaisseur du till sur les crêtes est inversement proportionnelle à l'acuité de celles-ci, indépendamment de l'altitude. Il ne fait donc aucun doute que la moraine de fond a jadis recouvert toute la région; sa répartition actuelle est fonction du degré d'inclinaison des versants et de la stabilité des matériaux que les glaces y déposèrent.

Au lac Vacher, une coupe laisse voir 50 cm de till sablonneux, de couleur pâle, reposant sur 75 cm de till plus compact de couleur plus sombre sans orientation de texture. Dans l'excavation du lac Ruth, une coupe longue de 335 m laisse voir une couche de till grossier et non tassé, dont l'épaisseur varie entre 20 cm et 1 m et qui contient des sables stratifiés, plus une grande quantité de cailloux et de blocs erratiques; elle repose sur une autre couche de till plus compact, de couleur plus sombre, dont l'épaisseur varie entre 45 cm et 1,45 m, et qui ne contient ni cailloux ni blocs erratiques (figure 2). Or, la couche sous-jacente a ici une texture orientée et son origine doit remonter au dernier mouvement régional des glaces en cette contrée, mouvement dirigé vers le sud-sud-est; la couche sus-jacente représente donc une déposition subséquente par la même nappe de glace en voie de disparition.

Ces deux coupes sont les seules entre plusieurs centaines à révéler ce qu'on pourrait appeler un till d'ablation, bien qu'on puisse voir, en ces blocs erratiques de diverses grosseurs reposant sur le till, l'indice d'une charge d'ablation très diffuse.

La moraine normale dépourvue de relief cède parfois la place à une moraine de fond bosselée qui prend d'ordinaire l'aspect d'un ensemble de tertres et de creux sans forme apparente. A Ferriman, sur le versant oriental

d'une arête de quartzite à 60 m du sommet, la moraine de fond forme, sur une distance de 300 m, des monticules aplatis de diverses grosseurs; ces monticules, qui se touchent par endroits et dont les côtés peuvent être plus ou moins inclinés et mesurer jusqu'à 3 m de hauteur, reposent sur une couche de till de 2 m ou plus d'épaisseur. D'après les analyses granulométriques effectuées en cet endroit et en d'autres (figure 3), ce till contient autant d'argile et de limon que le reste de la moraine de fond et on conclut à un degré normal de lessivage. L'irrégularité des formes du relief, que les photographies aériennes montrent bien, indique qu'il s'agit de moraine de glace «morte», déposée par des glaces stagnantes.

En certains endroits plus élevés où la couverture de till est plus épaisse qu'à la normale, on a remarqué une moraine de fond bosselée au relief moins marqué qu'à Ferriman. La grande dépression en forme de soucoupe sise à Fleming à l'ouest de Snowy Channel, par exemple, est recouverte d'une épaisse couche de moraine de fond raboteuse par endroits. Dans ce bassin on trouve cinq protubérances oblongues parallèles orientées vers le nord-nord-ouest, dont la plus grosse mesure 130 m de longueur, 20 m de largeur et 5 m de hauteur. Gravenor et Kupsch (1959) ont qualifié de «controlés» ce genre de dépôts qui révèle l'influence du mouvement antérieur des glaces. A cause de la direction structurale nord-nord-ouest de la roche en place il est difficile en d'autres cas de distinguer entre un alignement dû à la roche en place et un autre dû au mouvement des glaces.

Il convient de faire une distinction entre la moraine de fond bosselée et certaines protubérances isolées ou groupées qui reposent sur une surface de roche en place ou de moraine de fond dont la déposition serait antérieure à celles-ci. Ces «bosses», comme on les appelle ici, sont de dimensions et de formes très variables.

Les bosses isolées qu'on observe au fond et sur les flancs des vallées ont habituellement un sommet plat et des versants raides; leur allongement dans le sens de la pente est fonction du degré d'inclinaison de celle-ci. (figures 4 et 5). L'inclinaison de l'extrémité inférieure atteint souvent 60° sur une distance de 1 m à partir de la base que la solifluction active contribue à allonger davantage vers le pied du versant. Au centre de deux de ces bosses, y compris celle qui est illustrée à la figure 5, on a remarqué des creux de 30 à 60 cm de profondeur. Cette configuration en forme de beigne a été signalée par Gravenor (1956); il attribue ces formes à la fusion lente de glaces stagnantes dont la surface est cicatrisée de creux remplis de débris.

Les bosses qu'on trouve en terrain découvert sont moins nombreuses mais tout aussi bien développées que celles des vallées. Les plus beaux spécimens sont disposés en traînées et ont été observés au nord du ruisseau Joan et dans le voisinage de Fleming. A Fleming, une traînée de 14 bosses orientée vers 35° NW s'étend le long d'un col large et plat. Chaque bosse est de forme ovale, a un sommet plat et des parois raides. Les plus grosses, dont la longueur varie entre 15 et 60 m, la largeur entre 9 et 30 m et dont la hauteur moyenne est de 4 m, se trouvent au centre de la traînée. Celles des extrémités, en dépit de la raideur assez prononcée de leurs parois, ne mesurent que 1,50 m de hauteur et 6 m de longueur.

Toutes les protubérances étudiées sont formées de till, et ce till, même après examen au laboratoire, s'est révélé en tout point semblable à celui qui constitue la moraine de fond en cet endroit. Les analyses de laboratoire ont également montré que les cailloux contenus dans ce till sont anguleux et sub-anguleux et marqués de stries à la manière de cailloux de moraine de fond; aucune des coupes pratiquées sur ces bosses ne montre d'activité fluvio-glaciaire. L'analyse de la texture du matériel d'une de ces bosses révèle un arrangement fortuit des particules.

Ainsi, la composition de ces bosses nous interdit de les considérer comme des «kames». Néanmoins, on leur attribue en général une origine sous-glaciaire, soit par déposition de débris intra-glaciaires lors de la fonte, soit par remplissage des crevasses; en ce cas, les matériaux auraient pu être concentrés par pression dans des cavités sous-glaciaires (Hoppe, 1952). L'altitude de la traînée de bosses qu'on trouve à Fleming est inférieure à 15 m au-dessus du plus bas point sur le col, fait qui semble indiquer leur origine sous-glaciaire. Sur la pente faible du versant sud de Snowy Channel on trouve une semblable série de bosses alignées vers le pied de la pente et flanquées d'un chenal sous-glaciaire, fait qui milite en faveur d'une origine sous-glaciaire, plutôt que périphérique de ces formes.

Henderson (1959, p. 35), sans citer de cas particulier, se dit d'avis que les tertres (i.e. les bosses) de moindres dimensions «furent déposés par un écoulement local dans des mares peu profondes sur de la glace mince»; le till non trié de ces bosses, tel que décrit plus haut, ne semble pas corroborer cette opinion. Il prétend, à la suite de Gravenor (1955) que les protubérances mesurant de 3 à 4 m de hauteur «auraient pu être formées par l'effondrement du till au fond de cuvettes dans une glace

stagnante recouverte de débris morainiques». Quant aux plus grosses, Henderson n'est pas sûr qu'il s'agisse de kames, car il a lui aussi remarqué qu'elles se composent de till graveleux.

On trouve une topographie de marmites glaciaires, à échelle réduite, partout, dans la région, où l'on rencontre des poches plus profondes de débris morainiques. Dans la bande de collines on trouve communément, dans de profondes enclaves de roches en place remplies de débris morainiques, des marmites aux parois raides apparaissant ou isolées ou en groupes (figure 6). Ces marmites ont ordinairement une forme circulaire ou ovale, mesurent souvent entre 30 et 60 m de diamètre et ont, dans la plupart des cas, une profondeur de 6 m. Elles sont souvent remplies d'eau et forment des lacs plus ou moins nombreux suivant la saison. D'autres exemples de ces marmites furent observés dans la dépression de Schefferville, mais toujours en terrain bas et marécageux recouvert d'un épais manteau de végétation.

Bien que les principaux dépôts glaciaires soient formés de till, on rencontre un certain nombre de dépôts stratifiés, ou fluvio-glaciaires. Étant donné que pour certains dépôts bien délavés, la stratification, dans le sens d'alternance des couches de composition différente, n'est pas toujours apparente, l'expression «dépôts glaciaires stratifiés» telle qu'employée dans ce texte n'a qu'une valeur descriptive; seuls sont qualifiés de «fluvio-glaciaires» les dépôts dans lesquels les effets du délavage sont immédiatement apparents.

En somme, les dépôts fluvio-glaciaires, dans la région de Schefferville, ne sont pas très nombreux et leur répartition est fragmentaire, fait étrange vu l'abondance des chenaux d'écoulement fluvio-glaciaires. On doit en conclure à une pénurie de till au départ.

On a observé dans les dépôts délavés une grande variété de composition, à partir des dépôts rocailleux et extrêmement grossiers de Burnt Creek et Wishart jusqu'aux lits gravelleux et passablement homogènes de Schefferville. Les dépôts typiques, qui se situent entre ces deux extrêmes, sont constitués principalement de sables grossièrement stratifiés, de graviers et de galets, avec çà et là de minces lits de sable dépourvu de matériaux plus grossiers.

Les dépôts fluvio-glaciaires se trouvent presque invariablement au pied des versants et en bordure des dépressions à moins de 600 m d'altitude où ils forment de larges nappes recouvrant vraisemblablement une couche de till. L'eau qui s'écoule à la périphérie et en dessous de la glace en fusion

contient des débris auxquels viennent s'ajouter les matériaux intraglaciaires du glacier; ces débris sont entraînés vers le pied de la pente par cette eau qui en effectue un triage, dont resulte une vague stratification. Il arrive que ces lits, dont l'inclinaison est souvent prononcée, se fusionnent ou bien s'amincissent et s'achèvent soudainement. La majeure partie du débit solide est déposée au pied du versant, là où la vitesse de l'eau courante ne suffit plus au transport des débris; la nappe fluvio-glaciaire atteint son maximum d'épaisseur en cet endroit et va s'amincissant en contrebas.

La nappe de dépôts fluvio-glaciaires n'est pas partout dépourvue de relief; en certains endroits, elle est bosselée, comme c'est le cas du côté ouest du lac Star. En cet endroit, sur une pente de 5°, le manteau de till, d'environ 1 m d'épaisseur, est recouvert de 30 à 60 cm de sables et de graviers bien stratifiés; la surface est marquée de protubérances oblongues ou circulaires réparties sans ordre sur la pente; elles sont formées de matériaux fluvio-glaciaires et contiennent parfois d'épaisses lentilles de sable fin.

Une stratification aussi délicate dans ces bosses de débris morainiques est inconcevable sur une pente de cette raideur, à moins que les sables n'aient été empêchés de glisser jusqu'au pied de la pente par un obstacle quelconque, probablement le front d'une calotte glaciaire stagnante; les bosses se seraient formées dans des cavités à la base de cette masse de glace immobile. On a vu de ces bosses fluvio-glaciaires alignées en contrebas sur des pentes dont l'inclinaison atteignait 10°.

On trouve encore de ces dépôts fluvio-glaciaires dans des dépressions fermées, là où la glace a dû demeurer à l'état de stagnation, autour et en dessous de petites marmites glaciaires, par exemple. On ne trouve pas de débris dans les anciennes rigoles glaciaires si ce n'est un vernis de till. Il arrive cependant, à l'occasion, que le lit ou la partie inférieure de l'exutoire de ces rigoles soit couvert de dépôts stratifiés d'une certaine épaisseur.

Gradation de la texture des dépôts morainiques

On a remarqué que le degré de stratification des dépôts fluvio-glaciaires variait considérablement d'une forme à l'autre et, que même pour des formes identiques, il existait une gradation de texture et de degrés de stratification différents. Cette gradation est-elle fonction de la position du dépôt sur la pente? Existerait-il, du haut au bas d'une pente donnée, un changement progressif et continu de la grosseur des particules en même temps qu'une augmentation du degré de délavage, et ce, à partir du

till normal, lequel contient du limon et de l'argile dans des proportions de 20 p. 100, en passant par un till sablonneux non stratifié, jusqu'aux dépôts fluvio-glaciaires sablonneux stratifiés ne contenant que 2 p. 100 de limon et d'argile?

Pour trouver sur les lieux une réponse à ces questions il fallait un versant de grandes dimensions, dans lequel fussent pratiquées de nombreuses coupes à peu de distance les unes des autres. Or, la nature ne fait pas ainsi les choses. Aussi n'a-t-on trouvé que deux endroits convenables ayant un nombre suffisant de fosses artificielles.

C'est sur la route Nord, à 13 kilomètres de Schefferville en direction N 55°W, à 560 m d'altitude, qu'on a découvert le premier exemple de cette gradation texturale. A la surface, on n'aperçoit qu'un chenal peu profond qui dévale de biais, droit vers le nord, une faible pente. De chaque côté de ce chenal, le till dont l'épaisseur est de plusieurs mètres devient sur une distance de 150 m progressivement plus sablonneux à mesure qu'on s'approche du centre du chenal, bien qu'aucune stratification ne soit apparente. Dans le chenal même, à mesure qu'on s'approche du pied de la pente, le till devient progressivement plus grossier, puis bosselé et finalement bien stratifié.

Cette diminution de la quantité de matériaux fins dans le till doit être attribuable au ruissellement des eaux de fonte. A mesure que le débit augmente, le triage s'effectue plus facilement jusqu'à ce qu'au pied du versant la stratification soit nette.

Le second endroit, à l'extrémité nord-ouest du lac Ridge en bordure de la bande de collines, est beaucoup plus vaste que le premier. La gradation des sédiments n'y est pas limitée à une étroite bande centrée sur un chenal; elle est visible sur toute la largeur du versant. La figure 7 B montre la suite des matériaux morainiques du sud-ouest au nord-est, entre l'extrémité nord du lac Ridge et le lac La Cosa. A 550 m d'altitude, la couverture de till est mince. A 530 m, elle est plus épaisse et plus grossière. A 520 m, le till grossier fait place, assez brusquement, à des dépôts fluvio-glaciaires blocailleux vaguement stratifiés. On n'observe aucun changement comparable des formes de la surface qui en cet endroit est déjà légèrement bosselée. Dans un autre secteur du versant, ce changement est observé à 530 m d'altitude où il correspond à une rupture de pente. En terrain plat, au pied du versant, les dépôts fluvio-glaciaires sont bosselés (figure 8). Or, les dépôts proglaciaires stratifiés sont ordinairement disposés en couches frontales minces, dépourvues de relief. Ces dépôts fluvio-glaciaires bosselés doivent donc avoir été formés en contact avec des glaces stagnantes. Les bosses fluvio-glaciaires

(kames) mesurent, en moyenne, 6 m de diamètre; les plus grosses peuvent atteindre 3 m de hauteur. On n'a trouvé aucune de ces cuvettes qui résultent parfois de la fusion de petits blocs de glace stagnante.

En terrain bas, les dépôts fluvio-glaciaires augmentent en épaisseur et en dimensions au point de ressembler quelque peu à un groupe d'eskers; mais on ne trouve, et rarement, que des bouts d'eskers composés de limon sablonneux et de sable, (figure 7 A; endroits EE). Les photographies aériennes révèlent néanmoins un certain plan dans la répartition des arêtes et des bosses: à l'extrémité nord du lac Ridge, elles forment un parfait delta (figure 7 A; endroit D) dont l'origine se rattache aux voies d'écoulement fluvio-glaciaire venant du lac Star. Les traînées de bosses disposées en éventail, dont la pointe correspond au sommet du delta, marquent les lits d'anciens effluents glaciaires. D'autres sédiments ont été transportés de quelque part au nord-ouest jusqu'en cet endroit par voie de la vallée qui longe l'arête Star, comme en témoignent les dépôts fluvio-glaciaires alignés qui s'y trouvent. Les matériaux plus fins ont dû être charriés plus loin du pied du versant, car sur le bord occidental du lac La Cosa les dépôts, en certains endroits, sont formés presque exclusivement de sable.

Sur le versant de l'arête Star, les changements de texture sont plus progressifs qu'ailleurs. Le passage du till bosselé aux dépôts sablonneux stratifiés s'effectue sur une large bande qui suit approximativement la courbe de niveau de 530 m.

La stratification commence là où le volume d'eau est suffisant pour le triage et le délavage des matériaux. Sur les pentes raides, comme le long de la coupe AA (figure 7 B), la transition des dépôts non stratifiés aux dépôts stratifiés est brusque. Cette ligne de transition pourrait correspondre soit au lieu où le volume d'eau de fonte coulant sur la pente en dessous de la calotte glaciaire a augmenté suffisamment pour permettre le triage de particules plus grosses que le sable, soit, en d'autres cas, à la limite supérieure du côté d'un gros bloc de glace occupant le fond de la vallée. Sur des pentes douces, comme à l'extrémité sud de l'arête Star, la transition est moins brusque. La transition s'est effectuée dans ce cas en terrain presque plat, en un lieu qui devait être enfoui sous la glace au moment de la déposition des matériaux.

Un fait particulier semble écarter tout doute quant à l'origine sous-glaciaire des dépôts morainiques en cette région. A l'extrémité nord du lac Ridge, un chenal de drainage glaciaire traverse l'arête qui sépare ce lac du

lac La Cosa (figure 7 A; endroit C). Ce chenal, qui est orienté vers le nord-est et débouche sur un endroit sablonneux, semble avoir servi à l'écoulement des eaux de fonte, entre l'emplacement actuel du lac Ridge et celui du lac La Cosa. Il ne s'agit probablement pas d'un déversoir supra-glaciaire puisqu'il existe au moins deux exutoires plus bas—aux deux extrémités—pour le petit bassin qu'occupe maintenant le lac Ridge. On trouve une arête assymétrique de sable rattachée au chenal glaciaire et partiellement submergée dans le lac, et dont la crête aboutit au plancher du chenal. Une telle association, un esker engouffré sous la glace relié à un chenal de drainage sous-glaciaire, n'est pas rare. Le chenal en traversant l'arête a pratiqué une tranchée de 6 m de profondeur, à savoir 3 m de débris morainiques sablonneux et 3 m de roche en place. La déposition de ces débris est donc antérieure au chenal et par conséquent d'origine sous-glaciaire.

Interprétation des formes de la couverture de débris morainiques

La description des dépôts morainiques qui précède nous permet de retracer, en partie, les événements qui ont marqué les phases de glaciation concomitantes à leur déposition.

La mince couverture de moraine de fond, dont la composition est en moyenne, de 20 p. 100 de limon et d'argile et 80 p. 100 de sable et de gravier, est la seule forme de débris glaciaire à couvrir au moins les trois quarts de la zone de collines. Mais à mesure qu'on descend vers le terrain bas, la moraine de fond est progressivement ou remplacée ou masquée par d'autres formes de dépôts. La moraine de fond fut déposée par suite du mouvement régional de la glace; l'étude des stries et l'analyse de la texture du till dont est formée cette moraine (qui feront l'objet d'une autre communication traitant du mouvement des glaces) ont fourni des preuves à l'effet que le mouvement en question fut le dernier mouvement régional des glaces en cette localité. Dans le secteur de Schefferville, le mouvement s'est effectué vers le sud-sud-est. Bien qu'en plusieurs endroits les stries indiquent un mouvement régional en deux directions au moins, ni les observations sur le terrain ni les analyses, soit de texture soit de granulométrie du till, n'ont révélé l'existence d'une seconde couverture de till.

Autrement que par la texture de la moraine de fond même, les débris morainiques fournissent peu de preuves de mouvement glaciaire. A noter, l'absence complète de drumlins. Les traînées de débris avec noyau de roche sont rares; on n'a trouvé qu'une seule vraie traînée de débris, i.e. dépourvue de noyau rocheux: il s'agit d'un bourrelet de 6 m de long à

l'extrémité sud d'une butte de quartzite à Wishart. Pour ce qui est des formes dues à l'érosion glaciaire, les roches moutonnées ne sont pas bien façonnées et les stries sont vagues. En somme, le mouvement régional des glaces n'aurait jamais été très considérable. Au contraire, on a observé une foule de phénomènes ordinairement associés à des glaces stagnantes.

La moraine de fond bosselée témoigne des conditions lors de la fusion sur place des restes de la calotte glaciaire; le fait que les formes sont parfois «controlées», parfois «incontrolées», dépend de l'influence de la glace à une période antérieure d'activité.

Les bosses isolées ou alignées sont nécessairement des phénomènes de déposition ultérieurs à la moraine de fond sur laquelle elles reposent. Leur répartition, dans les deux cas, est en rapport avec la topographie locale. On trouve des bosses isolées, et aussi des marmites, à diverses altitudes, partout où de la moraine et des blocs de glace sont restés pris dans des dépressions fermées. On trouve parfois aussi des bosses isolées en terrain découvert à plus haute altitude. Mais les bosses alignées ne se retrouvent que là où il y a amplement de place pour leur formation, à savoir en terrain découvert à plus de 685 m d'altitude, où elles semblent avoir été déposées le long de lignes de crevasses, et en rapport avec le drainage sous-glaciaire.

La déposition de matériaux fluvio-glaciaires requiert de hautes températures et une activité glaciaire restreinte; mais ces conditions ne se réalisent qu'en période de déglaciation. Dans cette localité, les dépôts fluvio-glaciaires se trouvent dans des bassins de déposition, plus particulièrement en bordure de ces bassins, et sont en rapport avec les chenaux de drainage glaciaires. L'éparpillement des dépôts fluvio-glaciaires à la surface est signalé par Derbyshire (1960) qui en conclut, en s'appuyant également sur ses données de la complexité du drainage sous-glaciaire, à l'immobilité et à la désintégration sur place de la calotte glaciaire durant la période de déglaciation. A coup sûr, les dépôts fluvio-glaciaires sont le résultat de la phase finale de la fusion des glaces alors que la glace n'occupait plus que les dépressions, laissant les arêtes à découvert. La dépression de Schefferville est une de ces dépressions où la glace demeura plus longtemps que sur les collines voisines, comme en témoigne la topographie des environs du lac Ridge. De l'autre côté de la dépression, au nord-est de Schefferville, on sait que la moraine est surtout formée de till; la ville même est située en bordure de la dépression tandis que le quartier le plus bas a été construit sur d'épais dépôts fluvio-glaciaires semblables à ceux du voisinage du lac Ridge.

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Si la phase de retrait des glaces avait comporté des récurrences même partielles, on pourrait s'attendre à trouver, au moins dans les plus grandes vallées, des moraines terminales. Or, on ne relève la présence d'aucune moraine terminale. Il faut donc en conclure au retrait continuel des glaces durant cette dernière phase. Une récurrence de quelque importance aurait, en plus, selon toute vraisemblance, modifié ou détruit un bon nombre de chenaux de drainage glaciaires. Néanmoins, Henderson (1959, pp. 23-26) a qualifié de moraines terminales certains dépôts découverts dans des vallées du mont Geren (figure 1); bien que les recherches effectuées par l'auteur dans la vallée Goodwood, en bordure du mont Geren (figure 9), infirment cette interprétation; la présence ou l'absence de moraines terminales est d'une importance telle dans une étude de la déglaciation que le point de vue de Henderson doit être considéré.

Henderson suggère que le drainage d'un bloc de glace résiduelle occupant la vallée Goodwood, à une altitude de 530 m, s'effectua pendant un certain temps, en direction est vers les terrains bas de la vallée de Swampy Bay, à une altitude de 470 m, par la voie de vallées traversant l'arête intervallaire. Vis-à-vis le mont Geren, le col de l'arête qui sépare les deux vallées est à environ 750 m d'altitude et séparé du rebord oriental de la vallée Howells (à 610 m d'altitude) par 3 kilomètres de terrain onduleux.

Henderson dit avoir découvert des moraines terminales de chaque côté du col. Puisqu'il n'existe pas sur le col d'aire d'accumulation de névé convenable d'où une langue glaciaire eut pu se prolonger, la présence de moraines terminales à une telle altitude ne s'explique que par l'existence de glaces d'un ou de chaque côté du col. Henderson croit qu'une langue de glace qui occupait la vallée Goodwood se répandit d'abord par-delà le col, et y laissa des moraines terminales pour marquer les poussées successives, puis, se retirant du côté ouest du col y laissa dans un lac de barrage glaciaire des dépôts qui seraient censés indiquer les limites supérieures successives de la glace. Il ne présente aucune preuve séparée à l'appui de l'existence d'un lac pro-glaciaire.

Il est vraisemblable qu'au début de la déglaciation du mont Geren, les crêtes voisines et les plus hauts cols aient été les premiers points à émerger de la calotte. Petit à petit, les côtés du glacier se seraient éloignés de l'arête principale et du col en question. Le procédé qu'envisage Henderson aurait nécessité un reflux des glaces vers l'est en remontant la vallée Goodwood. Or, l'avance d'un glacier vers le haut d'une pente est un fait rare et n'est possible que sur une faible pente à condition que la source de

glace soit assez élevée pour fournir la force de propulsion nécessaire. De telles conditions n'existent pas en cet endroit. La vallée tributaire Goodwood est trop haute et tortueuse pour permettre facilement ce genre de poussée.

A mesure que la glace s'éloignait des versants du mont Geren, des chenaux latéraux et semi-latéraux ont probablement été creusés, et ce sont ces chenaux qu'on a pris pour des signes de récurrence glaciaire. On a trouvé dans la partie supérieure et dans la partie mitoyenne de la vallée Goodwood des marmites et diverses formes de till bosselé semblables à celles qu'on a trouvées dans d'autres vallées en cette région, mais on considère ces formes comme des signes de stagnation et d'amaigrissement des glaces et non de récurrence.

Même si on ne croit pas à l'existence de moraines terminales dans le secteur situé au nord du mont Geren, on n'exclut pas la possibilité de leur existence ailleurs en rapport avec l'amaigrissement de la calotte glaciaire. On n'en a pas trouvé, tout simplement. L'arrangement cyclique des moraines qu'on trouve au sud du lac Dyke, à quelques kilomètres au sud-est de Schefferville, semble être le fait de dépositions périodiques, soit sous-glaciaires, soit pro-glaciaires, mais les opinions quant au mode de formation de ces dépôts diffèrent radicalement (Ives, 1956; Henderson, 1959).

ÉTAT DES GLACES APRÈS LE MAXIMUM GLACIAIRE

Les mouvements régionaux des glaces dans les régions de Schefferville et du mont Geren, dont la faiblesse semble indiquer la proximité de la ligne régionale de partage de l'inlandsis, furent suivis de la phase finale de déglaciation. C'est dans cette région qu'à dû se dérouler ce dernier épisode ainsi qu'en témoignent l'abondance et la disposition des dépôts fluvio-glaciaires et les formes de glace morte, phénomènes ordinairement associés à de la glace stagnante fondant sur place. Bien qu'il soit un peu hasardeux de se fier aux seuls phénomènes de glace morte pour identifier une région d'amaigrissement définitif des glaces, il reste que les formes de ce genre sont plus fréquentes dans cette partie de la péninsule que dans la région du littoral. Le fait qu'on trouve des marmites et des bosses sur les hauteurs dans des dépressions fermées et des vallées démontre que des fragments de la calotte glaciaire y furent laissés après que celle-ci, amincie et stagnante, eut commencé à fondre sur place et à se rompre en quartiers séparés par les principales arêtes. En terrain découvert, les bosses isolées doivent être considérées comme le résultat d'une déposition fortuite, et les

traînées de bosses comme le résultat d'une déposition contrôlée par l'eau de fonte sous-glaciaire. On a trouvé peu de terrasses latérales; ce fait indique que la bordure glaciaire reculait trop rapidement pour permettre aux dépôts latéraux de se former, et que la glace, au moins sur les hauteurs, a disparu rapidement. Derbyshire (1959), cependant, mentionne une série de formes d'apparence deltaïques «accrochées», à diverses hauteurs, sur le versant est de la vallée Howells entre le lac Stakit et le lac Elross. Il s'agit apparemment de dépôts latéraux dont l'origine remonterait aux dernières phases de déglaciation alors qu'un lobe de glace résiduelle occupait la vallée Howells.

On croit qu'au cours de la phase finale de déglaciation le climat de cette région était comparable au climat actuel, ou plus doux (Manley, 1955; Ives, 1959) et que le retrait et la disparition des glaces furent très rapides (Derbyshire, 1959). Ceci dément l'hypothèse de l'expansion de certaines parties des calottes glaciaires à la suite d'une période de refroidissement accompagnée de l'accumulation de neiges fraîches (Henderson, 1959, p. 67). Seule l'englaciation de la majeure partie du plateau central aurait pu provoquer un renouveau de mouvement dans la région de glace résiduelle du centre de la péninsule. Or, l'étude de la morphologie de la région n'a fourni aucune preuve à cet effet. Le fait qu'un refroidissement considérable du climat ait occasionné une récurrence glaciaire dans la chaîne côtière de l'Alaska ne signifie pas nécessairement que le même phénomène se soit produit dans le centre de la péninsule du Labrador, (Henderson, 1959, p. 67), car les conditions de climat et de topographie sont, dans ces deux cas, complètement différentes.

En résumé, il semble que l'inlandsis devint climatiquement «mort» dans la région de Schefferville, au stade où il recouvrait encore complètement la surface, et fondit rapidement sur place laissant émerger d'abord les plus hautes crêtes. A mesure que la glace s'amincissait, révélant ainsi une plus grande part du sol, le taux d'ablation augmentait probablement; l'eau de fonte s'écoulait par de nombreuses rigoles sous-glaciaires et procédait au triage et à la redistribution des débris morainiques. La glace était plus épaisse dans les vallées plus profondes que sur les hauteurs adjacentes et prit par conséquent plus de temps à fondre. Les derniers cumulots de glace se trouvaient dans les plus grandes dépressions, mais il est peu probable qu'on n'arrive jamais à établir un lien de correspondance entre les restes de ceux-ci.

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A NOTE ON THE KASHKA-TASH GLACIER OF THE CAUCASUS, USSR

Robert M. Bone

The Kashka-Tash glacier is in the Caucasus Mountains, about 16 miles southeast of Mount Elbrus (Figure 1). This alpine glacier is situated in the narrow but deep Kashka-Tash River valley, which is part of the Baksan River valley system (Figure 2). The rugged Kashka-Tash Valley has a steep gradient, averaging 14° (1 : 0.24), and a terraced channel. High rocky ridges are found on both sides of the glacier, which has a northern exposure (Zyuzin, 1960).

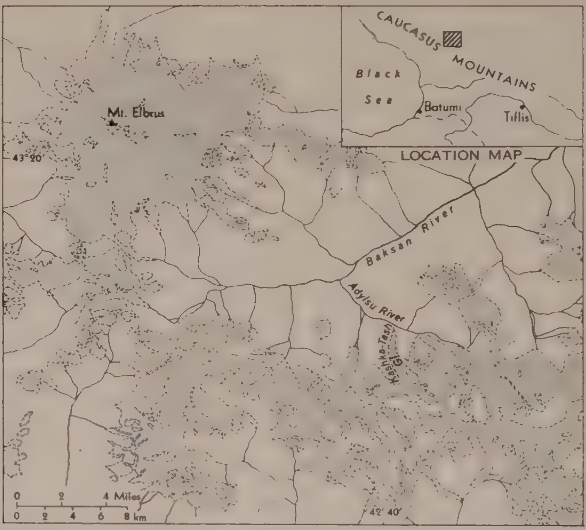

Figure 1

The location of the Kashka-Tash glacier in the Caucasus Mountains.

According to the recent glacier inventory of the American Geographical Society, this glacier is part of the Baksan group of central Caucasian glaciers (Field, 1958, p. 6-2-12). In this report it is stated, that "the main chain in the Central Caucasus, where it forms the watershed, is covered by continuous glaciers for over 80 miles. Eastward from Mount Elbrus, and to the north and south of the main chain, there are isolated glacier groups on the subsidiary chains or spurs."

The characteristics of the Caucasian glaciers are similar to those of alpine glaciers. However, many of the large glaciers are distinguished from their alpine counterparts by the absence of extensive névés owing to short,

MS. submitted January, 1961.

Figure 2

A sketch of the Kashka-Tash glacier. Dashed line indicates 1949 boundary of glacier.

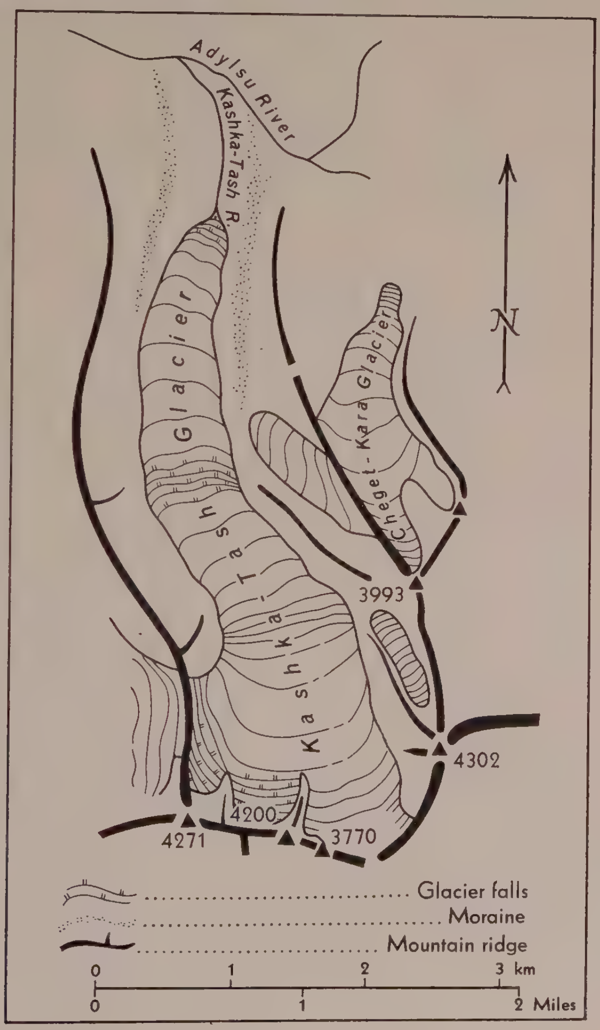

Figure 3

The Kashka-Tash Valley.

deep valleys that terminate at relatively high elevations. Thus the Caucasian névés tend to be narrow, steep, ice-sheathed slopes. In addition, avalanches are an important and sometimes a dominant source of nourishment for these glaciers (Field, 1958). These characteristics are found in the Kashka-Tash glacier, which contains steep ice falls and poorly developed névés and which is subject to frequent and large avalanches (Zyuzin, 1960, p. 366 and Figure 3).

THE RECESSION OF THE GLACIER

Since 1947, Russian scientists, led by A. S. Zyuzin, have studied the recession of the Kashka-Tash glacier. Annual observations, based on airphotos, were supplemented by the field work of geodetic surveys in 1949, 1951 and 1956. In addition the work of Al'tberg, (1928) particularly his 1927 photograph of the glacier, has allowed a number of conclusions to be drawn about the recession of the glacier.

The Kashka-Tash glacier has undergone extensive recession (Figure 4). From an examination of Al'tberg's photograph (1927) Zyuzin estimates that from 1927 to 1956, this glacier receded by at least 575 feet, and posibly 660 feet. Accordingly, the Kashka-Tash recession occurred at a rate of about 20 feet per year. Zyuzin notes that this rate of recession also characterizes the Elbrus glacier, which also has a northern exposure.

Recently (1949 to 1956), a rapid contraction of the Kashka-Tash width occurred, reaching a maximum recession of about 250 feet near its tongue. In detail, the glacier receded from an elevation of 7,771 to 7,867 feet, that is, by 96 feet. While the recent recession (1949 to 1956) varied from 13 to 26 feet per year, its annual average was 19 feet, which closely parallels its 30-year (1927 to 1956) average annual rate of 20 feet. According to the American Geographical Society's report, this rate of recession agrees with the general rate of recession for north-facing glaciers of the Baksan group (Field, 1958 p. 6-2-18).

Two interesting fluctuations in this general retreat were also recorded by airphotos. One was the intense recession along the left portion of the tongue, where the glacier receded almost 100 feet in two years. This rapid retreat of a portion of the glacier was due to frequent avalanches along the steep left slope of the valley. The other fluctuation was the growth of the tip of the glacier, caused by the accumulation of avalanching snow.

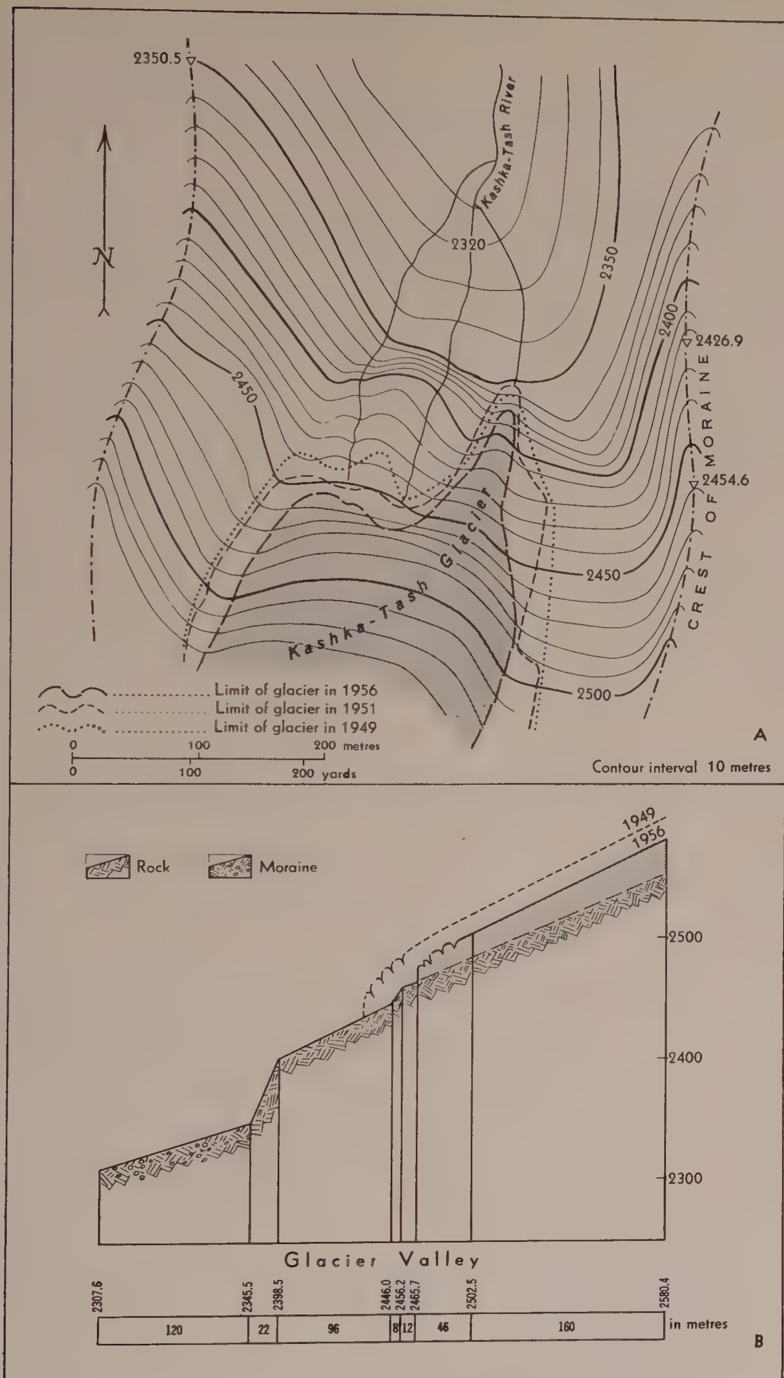

Figure 4

A. Recent fluctuations in the extent of the Kashka-Tash glacier.

B. A profile of the Kashka-Tash glacier.

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SOME ELEMENTS IN THE DEVELOPMENT OF THE NATIONAL ATLAS OF CANADA*

N. L. Nicholson

Abstract: The problems of producing an atlas of Canada that shows the nature, extent and use of the physical resources and their effect on the country's economy and society are intensified by the great size of the country, its federal political structure, and its bilingual culture. The work of compiling the information was organized by the Geographical Branch in co-operation with other governmental agencies that either produce maps or have source material. As it was impractical to produce a bilingual atlas, separate English and French editions were prepared, the nomenclature in the French edition being based on local usage, and French equivalents used for the geographical terminology. In addition to providing a record of what is known and unknown, the atlas provides a plan for future geographical research, and will be revised as new data become available.

The purpose of presenting this paper is to indicate the problems which were posed by the production of the national atlas of Canada, and the ways in which these problems were dealt with. It is inconceivable that any other country in the world will be faced with precisely the same situations in producing a national atlas. Every country is unique and four simple facts make Canada different from other national states. These are its great size—almost 4,000,000 square miles—the second largest country in the world; its relatively small population—barely 18,000,000; its federal political structure; and its bilingualism in national affairs. Nevertheless, other countries may be able to gain something of value to them from Canadian experience.

Atlases that cover a single country or political entity have been produced in increasing numbers since the turn of the century, but Canada was one of the first to produce an atlas of this kind. The first reference *Atlas of Canada* was published in 1906, and a second, revised edition appeared in 1915. By 1937 the need for a new edition was being felt, and the suggestion that a new atlas should be produced was made in that year by the Canadian Committee of the International Geographical Union (Grant-Suttie, 1947). In January 1943, the Canadian Social Science Research Council appointed a committee "to explore the possibilities of the preparation and publication of a comprehensive Atlas of Canada" and its report concluded that this could best be done in a centralized agency of the federal government

* Presented at the 19th International Geographical Congress, Stockholm, 1960, Commission on National Atlases.

(Brouillette, 1948). In December 1948 the Government of Canada decided that the Geographical Branch of the Department of Mines and Technical Surveys* should be entrusted with the task of preparing a new edition. As there were no records of the 1906 and 1915 editions, this was essentially an entirely new project.

ORGANIZATION

The first situation that had to be faced was that there were a number of governmental agencies that were either producing maps, or had source material that could be used for producing maps. In order to obtain co-operation and assistance, an interdepartmental committee was established, made up of representatives of the most important of these. Representation was from the Departments of Agriculture, Northern Affairs and National Resources, Fisheries, Transport, and Mines and Technical Surveys, as well as from the Dominion Bureau of Statistics, the Army Survey Establishment, the Canadian Meteorological Service and the Public Archives of Canada. The function of this committee was advisory, and initially it considered the broad problems of the project.

The first element considered was the purpose or purposes of the atlas–the physical "milieu" within which the atlas was to be developed. The view was taken that the *Atlas of Canada* should show the nature, extent and use of the physical resources of Canada, and their effect on the economy and society of the country. At the same time, it was recognized that such an atlas would also be a historical record of the stage of development of a country at a point of time. The *Atlas of Canada* therefore, would indicate the degree to which resources had been used, the way in which they had been exploited, the growth of the economy, and the extent of social, cultural and political development reached by Canada in 1951. Furthermore, if the *Atlas of Canada* was to be a national atlas in the best sense of the term, it was considered that it should present to the Canadian people and the world at large, a selection of authoritative maps of high accuracy and reliability, as well as high cartographic quality and artistry, which, when viewed in sequence should characterize and give meaning to the internal development of Canada and, to some extent, her international relations.

This having been established, it was necessary to determine the physical aspects of the kind of volume which could achieve these aims. A survey

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* In 1948 it was the Geographical Bureau, Department of Mines and Resources. The names were changed in 1949.

was made of all the national atlases available to the Geographical Branch at that time (Nicholson, 1952). By comparing and contrasting these atlases, the advisory committee was guided as to the general size, shape, projection, scale and contents of the proposed *Atlas of Canada*, and the decision was taken that the sheet, or open page size should be large enough to accommodate a map of the whole of Canada on a scale of 1:10,000,000 according to the Lambert conformal conic projection, with 49° and 77° as the standard parallels, with a polyconic projection superimposed above 80°N. latitude. It was also decided that the atlas should be loose leaf, each sheet being bound by means of a linen strip, to enable it to lie flat when the atlas was opened, so that individual sheets could be removed for special study if required.

It was also necessary to establish whether the geographical approach to the subject matter should be topical or regional, or both. The final decision was that it would be mainly topical, with some regional maps, particularly for showing populated places. This was the result of two main considerations. First, the atlas was to be *national* in character and, in any case, it was expected that the various provinces of Canada would produce their own atlases, which would, at least to a certain degree, be regional atlases. Secondly, the material available for the *Atlas of Canada* was most easily obtained on a topical basis.

The problem of the proportion of space to be allocated to the main branches of geography was considered in the light of the results of the survey of single-country atlases previously referred to. This indicated that approximately equal space should be devoted to the physical environment, to human geography, in its widest sense, and to economic geography. It also served as guide to the relative emphasis that might be placed on the topics within these broad groups.

Finally, the matter of whether an attempt should be made to produce a bilingual atlas occupied the attention of the committee. It was concluded that it was not technically possible to produce a series of maps of the atlas type that would be consistently and truly bilingual, and that the best that could be done would be to have a bilingual legend on each sheet. This was not considered a satisfactory compromise, so the decision was reached to produce two editions, one entirely in English and one entirely in French.

To aid in the preparation of the details of the contents, the committee then set up subcommittees covering the fields of agriculture, history, fisheries, meteorology and climatology, transportation and communications,

commercial and social matters, national resources, and topography and hydrography. To provide for topics not covered by these, a "miscellaneous" subcommittee was added. These subcommittees were asked to recommend to the main committee those maps which, in their view, were needed to represent their fields. These recommendations were then edited and adjusted until the contents of the new atlas were built up in fairly specific terms which could be portrayed on about 100 atlas sheets, and which would fulfill the broad purposes of the project. By October 1954 these planning stages had been completed. The subcommittees were disbanded and the work of the actual production commenced.

PRODUCTION

The production* of the *Atlas of Canada* was the concern of the Geographical Branch, which dealt with the acquisition of data, sometimes through its own field work, and the compilation, layout design, preliminary drafting, colors desired, and the style and size of the lettering. The first necessities were suitable base maps. Sufficient detail had to be shown on them, and yet not so much detail that the maps would look confused when the topical information was superimposed. To aid in clarity in using the maps when published, it was decided that the bases would generally be printed in a "faded" color rather than black. This meant that the line work had to be rather thicker than with a black base map. It also meant that, when special bases were required for which the faded color was not suitable, the base had to be re-drafted, using finer line work, and that different type had to be used for the lettering. This was the case with the bathy-orographical maps, for example, on which all water features and coastlines were to be printed in dark blue. The fundamental base was that which showed Canada as a whole on one sheet on a scale of 1:10,000,000 (approx. 158 miles to 1 inch). Other maps in the atlas were to be on scales that were simple multiples of this—half, one fifth, double, four times or ten times the basic scale, unless the nature of the topic warranted special treatment. The 1:10,000,000 scale was used generally as a full page map; the 1:20,000,000 scale was used where four maps on a page were required; and the 1:50,000,000 scale was used generally for a block of twenty small maps to

* The project called for an immense effort in drafting, photo-mechanics and lithography by the staff of the Map Compilation and Reproduction Division of the Department of Mines and Technical Surveys under the direction of E. D. Baldock, and the resulting atlas is recognized as a triumph of modern cartography and graphic arts. The binders were manufactured by a commercial firm and the assembling was carried out by staff of The Queen's Printer, Ottawa.

a page. The 1:5,000,000 scale was used to cover Canada in three parts—Eastern, Western and Northern Canada—while the 1:2,500,000 scale was for a detailed map in four parts covering all of Southern Canada. Each part was to occupy a full page of the atlas, covering the Gulf of St. Lawrence area, the Great Lakes area, the Prairies and the Far West. The most detailed sheet in the atlas was to be on a scale of 1:1,000,000 in order to show the physiography of southern Ontario. Occasionally it was necessary to deviate from these standard scales. The maps showing typical weather situations, for instance, required areal coverage of parts of the U.S.A. and Greenland as well as Canada. This could only be achieved by using a scale of 1:30,000,000. These considerations resulted in four basic page layouts. To show Southern Canada on a scale of 1:10,000,000 required only half a page, and the device of two maps of Southern Canada on a single sheet was used frequently.

Meanwhile, the material to be printed on the base maps was being collected. This material was submitted by the contributing departments in a variety of ways. Sometimes it was in the form of a well compiled and well drawn sheet which, apart from details as to style, form and lettering, was almost ready for the printers. At the other end of the scale, some of the information submitted was merely in the form of raw data or statistics which had to be plotted, or from which a suitable series of maps had to be completely designed and compiled. In some instances information was not available in Ottawa, and had to be obtained from private individuals, provincial governments, or special field work by the Geographical Branch.

The first sheet was sent for final drafting and printing in February 1955. In order to keep the number of printings for each sheet to a reasonable minimum, sample color charts of combinations of standard colors were produced, from which the most desirable were selected. There were four basic colors required for most maps, that could not be combined—a natural tint of purplish grey which had been selected for most of the base maps; black, mainly for lettering; light blue for water areas; and light buff for areas not embraced by any other color. Eight other basic colors* were used in various combinations which, together with the use of four different screens,† produced up to thirty tints. Not all were required for every sheet, but for a few special maps, such as that on bedrock geology and soil regions,

* Yellow, light brown, dark brown, green, light blue, dark blue, pink and red.

† 100 dots to the inch; 100 lines to the inch; 65 lines to the inch; and 30 lines to the inch.

more than this number was required, and special combinations of rulings and colors had to be used in order to portray the information. Each map was photo-color proofed on opaque plastic sheets by exposing each color negative, with the appropriate screen, to successive colored bichromated albumen coatings. The first of the 110 sheets came off the press in September 1955, and the final sheet of the English edition left the press on October 31, 1958.

THE FRENCH EDITION

A French edition of the *Atlas of Canada* had never previously been produced, and the principal problems in doing so were three-fold. First there was the problem of place names and the names of physical features. All generics, such as rivers and lakes, appear in the *Atlas du Canada* in their French form, but the guiding principle in establishing the geographical names themselves in Canada is local usage. Hence no names appear in French in the *Atlas du Canada* unless a precedent for French usage could be determined. Thus, for example, London, Ontario, does not appear as Londres because the French form for the name of this city is never used by Canadians. Cold Lake appears as Lac Cold, and Porcupine Plain appears as Plain Porcupine. Nova Scotia, on the other hand, appears as Nouvelle-Ecosse. To determine precedents for French usage was a time-consuming task and was entrusted to a special committee.

Secondly, there was the problem of French equivalents for geographical expressions and terms used mostly in the map legends and the notes on the backs of the sheets. This was in many ways more complicated because the scientific vocabulary of French-speaking Canadians does not always coincide with that of French-speaking people in other parts of the world, just as English used in Canada is not precisely the same as English used in the United Kingdom. For example, the Canadian term for "Silo de blé" is "Elévateur à Grain", and "lard" would be described as "saindoux" in France. In Canada we talk of "Région métropolitaine de Montréal", whereas in France the same meaning would be given by the expression "Grand Montréal" or "Montréal et banlieue". In Canada, too, the word "physiographie" is used in many instances, when the French would use "morphologie". Each term, or phrase, had to be considered individually.

Thirdly, there was the problem, or group of problems, of converting the material used to reproduce the English edition into reproduction material for the French edition as economically as possible. Among these

was the fact that the French equivalents of words were seldom of the same length as they were in English, and the sizes of the type used for them had to be adjusted accordingly. If the words were longer and were to appear on the face of the map, care had to be taken that important map details were not obscured.

ARRANGEMENT

The sheets of both the English and French editions of the atlas were arranged in such a way that, if they are read from beginning to end, as with a textbook, they give a coherent story in maps of Canada's geography in all its aspects—historical, physical, human, economic, social and political. Thus the first three sheets deal with the origins of the country; one shows the routes taken by the principal explorers, and the other two show portions of the original maps that resulted from exploration.

From the old maps, the atlas proceeds to modern mapping with examples of present-day topographical sheets and aeronautical and hydrographic charts. This leads to maps of the physical aspects of Canada's geography—relief, geology, magnetism, tides and an extensive section of fourteen sheets on various aspects of climate. This is followed by maps of drainage basins, profiles of major rivers, soil and forestry maps, and an interesting set of six sheets, each of which contains a number of small maps showing the ranges of representative insects, plants, trees, mammals, birds and inland fish.

The next section of the atlas is concerned with human resources and shows such things as distribution of population, origins of the people, principal religions, and birth, marriage and death rates.

The third part of the atlas shows some of the ways in which the people have used the physical resources—what is generally referred to as economic geography. There are maps of fisheries, sawmills, pulp and paper mills, various aspects of agriculture, such as the distribution of farm animals and crops, mining, hydro- and thermoelectric power and manufacturing. This section ends with maps of transportation and communication which have developed as a result of resource use. They deal with canals, railways, airlines, shipping and radio and television networks.

The last twenty maps in the atlas are concerned with the way in which institutions and towns, cities and rural municipalities have become distributed as a result of these activities. There are maps of hospitals, universities,

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libraries, art galleries and museums; all populated places, including large-scale maps of eight larger cities, showing their growth and present land use; and maps of census divisions, and electoral districts. The last two sheets show the way in which Canada evolved politically from a series of colonies to a three-ocean state, and its overseas partners in the Commonwealth, the United Nations Organization, the Colombo Plan and the North Atlantic Treaty Organization.

THE FUTURE

A comparison of the 1906 and 1915 editions of the *Atlas of Canada* with the latest edition shows at once that there has been gradually decreasing dependence on statistical diagrams. This is partly a reflection of the fact that the precise location of Canada's resources has gradually become more accurate. This increased accuracy is the result of a two-pronged attack—one by the surveyors, physical geographers, airphoto interpreters and the like, who record physical data, and the other by the economists and economic geographers, who by and large, record economic and social data. While the first group have been perfecting their techniques of recording and analyzing material gathered in the field, the second group have been perfecting their techniques of collecting and analyzing other data by other means. The effectiveness of these approaches is evident in the new *Atlas of Canada*. But the new atlas is not only a record of what is known; by its short-comings and omissions, it is also a record of what is not known, and so provides a plan for future geographical research and investigation. To accommodate this final element in the project and to enable new information to be mapped and inserted in the *Atlas of Canada*, was an additional reason for binding the new edition loose-leaf. The task now is to revise many of the sheets, from time to time, or reconstruct them completely, as the nature of the data warrants, and to prepare entirely new maps as new knowledge is required.

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QUELQUES ASPECTS DE L'ÉLABORATION DE L'ATLAS NATIONAL DU CANADA*

N. L. Nicholson

Résumé: Vu la vaste superficie du pays, sa structure politique de nature fédérale et sa culture bilingue, il s'est avéré extrêmement difficile de publier un atlas du Canada démontrant la nature, l'étendue et l'usage de ses ressources physiques et leurs effets au point de vue économique et social. La Direction de la géographie, avec le concours des autres agences gouvernementales intéressées dans la publication de cartes géographiques ou disposant de matériaux susceptibles à en produire, a organisé la compilation des documents. La réalisation d'un atlas bilingue jugée impraticable, deux éditions, l'une française et l'autre anglaise, furent préparées. La nomenclature dans l'édition française est réglée par l'usage et la toponymie. En plus de dresser un bilan de nos connaissances, l'atlas pourvoit à un programme de recherches géographiques et sera revisé au fur et à mesure que de nouvelles données nous seront parvenues.

La présente communication traite des problèmes relatifs à la publication de l'atlas national du Canada et de la façon dont ces problèmes furent résolus. Chaque pays ayant ses particularités, les problèmes que pose la préparation d'atlas nationaux dans d'autres pays sont sans doute différents. Le Canada a rencontré quatre difficultés: sa vaste superficie—environ 10,000,000 de kilomètres carrés—qui en fait le deuxième pays du monde par ordre de dimensions; sa population relativement faible—à peine 18,000,000; sa constitution fédérale; et, enfin, le caractère bilingue de son administration centrale. Néanmoins, on peut espérer que d'autres pays pourront profiter de son expérience dans ce domaine.

Depuis le début du siècle, un nombre toujours croissant de pays ont publié des atlas nationaux; le Canada est à l'avant-garde en ce domaine. La première édition de *l'Atlas du Canada* parut en 1906, la seconde, revisée, en 1915. Vers 1937, la nécessité d'une nouvelle édition commençait à se faire sentir et une suggestion à cet effet fut présentée la même année par le Comité canadien de l'Union Géographique Internationale (Grant-Suttie, 1947). En janvier 1943, le Conseil canadien des recherches en sciences sociales choisit un comité «chargé d'étudier la possibilité de préparer et de publier un Atlas du Canada». Ce comité en vint à la conclusion qu'il serait préférable de confier un travail de ce genre à un organisme du

* Donné au 19e Congrès international de géographie, Stockholm, 1960, Commission des Atlas Nationaux.

Gouvernement fédéral (Brouillette, 1948). En décembre 1948, le Gouvernement du Canada confia la préparation de cette nouvelle édition à la Direction de la géographie du ministère des Mines et des Relevés techniques.* Puisqu'il n'existait aucun dossier des éditions de 1906 et 1915, il s'agissait d'un projet complètement distinct.

L'ÉLABORATION

D'abord, il existait plusieurs organismes gouvernementaux qui produisaient des cartes ou disposaient de matériaux susceptibles de servir à en produire. En vue de s'assurer l'assistance et la coopération de ces divers organismes, on créa un Comité interministériel formé de représentants des principaux ministères en question, à savoir les ministères de l'Agriculture, des Affaires du Nord canadien et des Ressources nationales, des Pêcheries, des Transports, des Mines et des Relevés techniques, en plus du Bureau fédéral de la statistique, des services topographiques de l'Armée, de la Direction de la météorologie et des Archives publiques du Canada. Ce comité en sa qualité d'organisme consultatif considéra d'abord les grandes lignes du projet.

En premier lieu, on chercha à déterminer les buts de l'atlas—le milieu physique que l'atlas devrait représenter. On en vint à la conclusion que *l'Atlas du Canada* devrait montrer la nature, la répartition et l'utilisation des ressources physiques du Canada et leur influence sur l'économie et la population du pays. Un atlas de ce genre serait en même temps un document historique montrant le degré d'évolution du pays à une période donnée. C'est-à-dire que *l'Atlas du Canada* montrerait le degré d'utilisation des ressources naturelles, leur mode d'exploitation, le progrès de l'économie ainsi que le niveau d'évolution sociale, culturelle et politique du Canada en 1951. De plus, on fut d'avis qu'un *Atlas du Canada* pour être véritablement un atlas national devrait présenter tant au peuple canadien qu'au reste du monde un choix de cartes originales d'une grande précision en même temps que de qualité cartographique et artistique excellente, cartes qui, vues en séquence, illustreraient de façon cohérente le développement du Canada en même temps que, jusqu'à un certain point, ses relations internationales.

Les buts précisés, il fallait déterminer la forme que devrait prendre l'Atlas en vue d'atteindre les fins proposées. On effectua à cette fin une

* En 1948, cet organisme portait le nom de Service de la géographie du ministère des Mines et des Ressources. Ce nom fut changé en 1949.

étude comparative de tous les atlas nationaux dont disposait alors la Direction de la géographie (Nicholson, 1952). Ce relevé fournit au comité consultatif certaines idées directrices quant au format, à la projection, à l'échelle et au contenu du futur *Atlas du Canada*. On convint que chaque planche devrait être de dimensions propres à accommoder une carte du Canada à 1:10,000,000 basée sur la projection conique conforme de Lambert ayant pour parallèles standard 49° et 77°, et d'une projection polyconique ordinaire pour les régions au-dessus du 80e degré de latitude nord. On décida également que les feuilles de l'Atlas seraient mobiles: une bande de toile relierait chaque feuille par son milieu au volume; ainsi chaque feuille ouverte demeurerait à plat et n'importe quelle planche pourrait, au besoin, être détachée pour examen séparé.

Il fallait également décider si la matière serait traitée par sujet ou par région ou des deux façons à la fois. Or, l'Atlas devait avoir un caractère national et de toute façon on s'attendait à ce que les diverses provinces du Canada produisent leurs propres atlas qui, dans une certaine mesure, seraient des atlas régionaux. De plus le matériel disponible pour *l'Atlas du Canada* pouvait s'obtenir plus facilement par sujet. On convint donc que la matière serait traitée par sujet et qu'on inclurait quelques cartes régionales, surtout pour montrer les régions habitées.

En ce qui avait trait au nombre de planches qu'on devait consacrer à chacune des principales branches de la géographie, les décisions furent influencées par les résultats du relevé des atlas nationaux, ci-haut mentionné. Ce relevé indiquait qu'on devait accorder une importance égale au milieu physique, à la géographie humaine, au sens le plus large du mot, et à la géographie économique, et indiquait en outre lesquelles des subdivisions de ces branches devaient être davantage soulignées.

Enfin, le comité étudia la possibilité de produire un atlas bilingue. On en vint à la conclusion qu'il était impossible, du point de vue technique, de produire une série de cartes d'atlas qui fussent véritablement bilingues et que la meilleure alternative serait de fournir une légende bilingue pour chaque carte. Toutefois ce compromis fut jugé inacceptable et dès lors on décida de préparer deux éditions, l'une entièrement anglaise, l'autre entièrement française.

Le Comité de l'Atlas organisa ensuite divers sous-comités pour veiller à la préparation des détails du contenu touchant les domaines suivants: l'agriculture, l'histoire, les pêcheries, la météorologie et la climatologie, les transports et les communications, les affaires commerciales et sociales, les

ressources nationales, la topographie et l'hydrographie. Un autre comité fut chargé des «sujets divers» non inclus dans les sujets précités. Ces sous-comités devaient recommander au comité principal les cartes qui leur semblaient les plus aptes à représenter leur sujet respectif. On rédigea ces recommandations et on en choisit un nombre suffisant pour couvrir une centaine de planches destinées à former le contenu de l'Atlas en même temps que servir les fins générales du projet. Au mois d'octobre 1954, les plans étaient terminés. Les comités furent alors dissous et le travail de production proprement dit commença.

LA PRODUCTION

La production* de *l'Atlas du Canada* fut confiée à la Direction de la géographie qui s'occupa d'obtenir, en certains cas grâce au travail sur le terrain de son propre personnel, les données nécessaires, et de voir à la compilation, à la mise en page, au dessin préliminaire, au choix des couleurs de même qu'au style et aux dimensions du lettrage. Il fallait en premier lieu disposer de cartes de base convenables. Ces cartes devaient être passablement détaillées sans toutefois paraître encombrées après l'inscription des renseignements de chaque sujet. En vue d'ajouter à la clarté des cartes de l'Atlas on décida d'inscrire les renseignements de base en une couleur estompée plutôt qu'en noir. Les traits devaient donc être plus gras. De plus, lorsqu'on eut besoin d'une carte de base spéciale dans laquelle un fond estompé ne suffisait pas, il a fallu en dessiner une aux lignes plus fines et adapter le lettrage en conséquence. Ce fut le cas, entre autres, des cartes du relief sous-marin sur lesquelles l'hydrographie et le littoral devaient apparaître en bleu foncé. On choisit comme carte de base fondamentale celle où le Canada entier occupait toute une planche à l'échelle de 1:10,000,000 (soit environ 158 milles au pouce). L'échelle de chacune des autres cartes de l'Atlas devait représenter un multiple de ce chiffre— moitié, cinquième, double, quadruple ou décuple, à moins que la nature du sujet n'en voulut autrement. Une planche pouvait accommoder soit une carte du Canada à 1:10,000,000, soit quatre à 1:20,000,000, ou soit vingt à 1:50,000,000. La carte du Canada à 1:5,000,000 occupait trois planches,

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* La mise en œuvre de cet ouvrage, tant du point de vue dessin que des processus photographiques et lithographiques, a exigé une somme considérable de travail de la part du personnel de la division du Dessin et impression des cartes de notre Ministère, que dirige M. E. D. Baldock. Cet Atlas est considéré désormais comme un chef-d'œuvre de cartographie et des arts graphiques. Le solide auto-relieur a été fabriqué par une firme de l'extérieur tandis que le travail d'assemblage a été confié au personnel de l'Imprimeur de la Reine.

une pour l'Est, une pour l'Ouest et une pour le Nord, tandis que la carte détaillée à 1:2,500,000 couvrait toute la partie sud du Canada en quatre planches, dont une pour la région du golfe Saint-Lauraent, une pour la région des Grands lacs, une pour la région des Prairies et une pour l'extrême Ouest. La carte la plus détaillée montrerait la morphologie du Sud de l'Ontario à l'échelle de 1:1,000,000. En certains cas, il fut impossible de s'en tenir à ces échelles. Les cartes illustrant des cas typiques de température, par exemple, devaient montrer, outre le Canada, une partie des États-Unis de même que le Groenland, ce qui nécessitait l'emploi de l'échelle de 1:30,000,000. Ainsi, le contenu des planches de l'Atlas fut disposé de quatre façons principales, tel qu'indiqué à la figure 1. Puisque la carte du sud du Canada à 1:10,000,000 n'occupait que la moitié d'une planche on présenta fréquemment deux de ces cartes sur la même planche.

Dans l'entre-temps, l'on recueillait les données qui devaient paraître sur la carte de base. Les ministères concernés présentèrent ces données de diverses manières. Parfois, ces renseignements étaient présentés sur des feuilles bien préparées et bien dessinées qui, sauf pour certains détails de style, de forme ou de lettrage, étaient pour ainsi dire prêtes à imprimer. Parfois, ils étaient soumis sous forme de données statistiques seulement et on devait procéder au travail de compilation avant de pouvoir enfin préparer et dessiner une série convenable de cartes. En certains cas, les renseignements désirés n'étaient pas disponibles à Ottawa et on devait soit s'adresser à des sources privées ou à des gouvernements provinciaux, soit envoyer sur le terrain des membres du personnel de la Direction de la géographie pour y effectuer des recherches sur place.

En février 1955, la première planche fut expédiée pour le dessin définitif et l'impression. Afin de réduire le nombre d'impressions à un minimum raisonnable, on prépara des échantillons d'échelles de couleurs pour les couleurs de base, parmi lesquels l'on choisit les meilleures. Quatre des couleurs fondamentales requises pour la plupart des cartes ne pouvaient être combinées: une teinte neutre de gris violacé qu'on devait employer sur la plupart des cartes de base, le noir, employé surtout pour le lettrage, le bleu pâle pour l'hydrographie, et enfin, un jaune chamois pour les régions où on n'ajouterait rien à la carte de base. On utilisa huit autres couleurs de base* qu'on combina de diverses manières en employant quatre trames différentes†, de façon à obtenir une trentaine de teintes. Toutes ces teintes

* Jaune, brun clair, brun foncé, vert, bleu clair, bleu foncé, rose et rouge.

† 100 points au pouce; 100 lignes au pouce; 65 lignes au pouce; 30 lignes au pouce.

n'étaient pas requises pour chaque planche, mais pour quelques cartes spéciales, telles que les cartes de la géologie et des sols, il en fallut encore davantage et on a dû avoir recours à des combinaisons spéciales de réglures et de couleurs pour arriver à représenter les renseignements de façon adéquate. On tira de chaque carte une épreuve photographique en couleur sur feuilles de plastique opaque, en exposant chaque négatif en couleur, avec la trame appropriée, à des couches successives d'albumine dichromée colorée. On acheva d'imprimer la première des 110 feuilles de l'édition anglaise en septembre 1955, et la dernière, le 31 octobre 1958.

L'ÉDITION FRANÇAISE

On n'avait jamais auparavant publié une édition française de *l'Atlas du Canada*. Pour ce faire, on a dû résoudre trois principaux problèmes. En premier lieu, il y avait le problème de la toponymie et des noms des formes du relief. Les termes génériques comme rivières, lacs apparaissent en français dans *l'Atlas du Canada*, mais au Canada, en général, le choix des toponymes proprement dits est réglé par l'usage. Par conséquent, seuls apparaissent en français dans *l'Atlas du Canada* les noms pour lesquels un équivalent français existait déjà. Par exemple, London, en Ontario, ne devient pas Londres parce que le nom français de cette ville n'est jamais employé par les Canadiens; Cold Lake devient lac Cold, Porcupine Plain, plaine Porcupine. Par contre, Nova Scotia devient Nouvelle-Écosse. Il fallait beaucoup de temps pour vérifier l'existence d'équivalents français pour ces noms et cette tâche fut confiée à un comité spécial.

En second lieu, il y avait le problème de l'équivalent français d'expressions géographiques et de termes utilisés principalement dans la légende des cartes et dans les notes au verso des feuilles. Ce problème était d'autant plus complexe que le vocabulaire scientifique des Canadiens français ne coïncide pas toujours avec celui des peuples francophones en d'autres parties du monde, tout comme l'anglais en usage au Canada n'est pas précisément le même que celui du Royaume-Uni. Par exemple, on dit «élévateur à grain» au lieu de «silo de blé», et on appelle «lard» au Canada ce qu'on appelle «saindoux» en France. Au Canada, on parle de la «région métropolitaine de Montréal», alors qu'en France, on dirait «le Grand Montréal» ou «Montréal et banlieue». Au Canada, on emploie également le terme «physiographie» pour ce que les Français appellent «morphologie». Il fallait étudier séparément chaque terme, chaque locution.

En troisième lieu, il fallait, sans trop augmenter les frais, adapter à l'édition française les matériaux utilisés pour la production de l'édition anglaise. Par exemple, l'équivalent français des mots employés était rarement de longueur égale aux mots anglais et par conséquent il fallait employer des caractères de grosseur différente. Lorsqu'un mot plus long devait apparaître sur la carte même, il fallait s'assurer qu'aucun détail cartographique important ne fut caché.

LA DISPOSITION DES PARTIES

La disposition des feuilles de l'Atlas est telle qu'en examinant celui-ci du commencement à la fin, comme un livre, on a une vue d'ensemble cohérente, au moyen de cartes, de la géographie du Canada, sous tous ses aspects—historique, physique, économique, social et politique. Ainsi, les trois premières planches traitent des origines du pays. Une de ces planches montre les routes des principaux explorateurs et les deux autres montrent des parties des premières cartes qui résultèrent de ces explorations.

Après les cartes anciennes viennent les cartes modernes avec exemples des plus récentes cartes topographiques, aéronautiques et hydrographiques. On passe ensuite à l'aspect physique de la géographie du Canada—le relief, la géologie, le magnétisme terrestre, les marées, plus une importante série de quatorze planches illustrant les divers aspects du climat. Viennent ensuite des cartes des bassins hydrographiques, des profils des principaux cours d'eau, des cartes des sols et des forêts, plus une intéressante série de six planches dont chacune contient un certain nombre de petites cartes montrant la répartition géographique des principaux insectes, plantes, arbres, mammifères, oiseaux et poissons d'eau douce.

La seconde partie de l'Atlas relève les ressources humaines et montre par exemple la répartition géographique de la population, les origines ethniques des habitants, les principales religions, ainsi que les taux de natalité, de mariage et de décès.

La troisième partie de l'Atlas montre quelques-uns des modes d'utilisation des ressources physiques, ce qu'on appelle généralement la géographie économique. On y trouve des cartes des pêcheries, des scieries, des fabriques de pâtes et papiers, de divers aspects de l'agriculture, tels que la distribution des animaux de ferme et des récoltes, plus la répartition des mines, des usines hydro-électriques et thermo-électriques et des manufactures. Cette section s'achève par des cartes des réseaux de transports et

de communications qui ont concouru à l'exploitation des ressources naturelles. Ces cartes montrent les canaux, le réseau ferroviaire, les routes de transport aérien, le transport maritime ainsi que les réseaux de radio et de télévision.

Les vingt dernières cartes de l'Atlas montrent la façon dont sont réparties, par suite de ces activités, les institutions, les villes, les cités et les municipalités. On y trouve des cartes montrant les hôpitaux, les universités, les bibliothèques, les galeries, les musées, plus toutes les régions habitées, y compris des cartes à grande échelle des huit plus grandes villes du pays lesquelles montrent l'évolution de ces villes et leur utilisation actuelle du terrain, et enfin des cartes des divisions de recensement et des circonscriptions électorales. Les deux dernières planches montrent l'évolution politique du Canada d'une série de colonies à un État borné par trois océans, ainsi que nos partenaires d'outre-mer dans le Commonwealth, l'Organisation des Nations Unies, le Plan Colombo et l'Organisation du Traité de l'Atlantique Nord.

PERSPECTIVES D'AVENIR

En comparant la dernière édition de *l'Atlas du Canada* avec les éditions de 1906 et 1915, on remarque une diminution progressive de l'importance accordée aux simples diagrammes statistiques. Cette tendance est attribuable en partie au fait qu'on a réussi graduellement à préciser davantage la localisation des ressources du Canada, et ce par deux moyens: d'une part, les arpenteurs, les géographes, les préposés à l'interprétation des photos aériennes et autres chargés de recueillir les données physiques ont amélioré leurs méthodes de rapport et d'analyse des renseignements recueillis sur le terrain; d'autre part, les économistes et les géographes, qui en général s'occupent de recueillir les renseignements d'ordre économique et social, ont perfectionné leurs méthodes de compilation et d'analyse de ces données. Le nouvel *Atlas du Canada* témoigne de l'efficacité de ces diverses méthodes. Mais, si le nouvel atlas témoigne de nos connaissances actuelles, il témoigne également, par ses omissions, de nos lacunes et pourra servir de guide à l'établissement d'un programme de recherches géographiques. C'est surtout pour tenir compte de cet aspect du projet, c'est-à-dire l'insertion subséquente de planches supplémentaires, qu'on a choisi une reliure à feuilles mobiles pour *l'Atlas du Canada*. Il reste maintenant à

reviser plusieurs des planches au besoin ou à les refondre complètement, suivant la nature des renseignements, et à préparer de nouvelles cartes à mesure que s'étendront nos connaissances géographiques.

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FUR TRAPPING IN THE MACKENZIE RIVER DELTA

W. A. Black

ABSTRACT: Fur trapping has been declining in importance in the Mackenzie River delta since 1952, and this decline has been associated with falling prices for fur. Although fur trapping is the economic backbone of the area, the general trend has been towards a reduced use of the basic fur resources. Moreover, financial returns from furs are, in general, no longer sufficient to provide for new trapping equipment or to provide an adequate livelihood for the native trappers. In addition, local trapping methods give rise to low-quality pelts with attendant low prices, in the face of which, the native trapper has tended to reduce his fur take. The incentive to produce high-quality furs is not likely to be strong while prices continue low and while a market for low-grade furs exists. The most pressing problems confronting the native people of the delta are the rehabilitation of the trapping areas and the production of high-quality pelts.

RÉSUMÉ. Depuis 1952 le piégeage perd de son importance dans le delta du fleuve Mackenzie par suite de la baisse du prix des fourrures. Bien que la traite des fourrures soit la principale source de revenu de cette contrée, l'utilisation de cette ressource fondamentale a tendance à diminuer. De plus, les revenus que procure la traite des fourrures ne suffisent plus, en général, à l'achat de matériel nouveau ni même à la subsistance convenable des trappeurs indigènes. Les méthodes locales de piégeage fournissent des pelleteries de qualité inférieure, qui commandent par le fait même des prix peu élevés, de sorte que le trappeur a tendance à diminuer la quantité de ses prises. Tant que les prix demeureront bas et qu'il existera un marché pour des pelleteries de qualité inférieure, il est peu probable qu'on s'efforce de produire des fourrures de haute qualité. Les problèmes les plus urgents avec lesquels est aux prises la population indigène du delta sont le repeuplement des régions de chasse et la production de pelleteries de haute qualité.

This paper is an economic appraisal of the fur-trapping industry of the Mackenzie River delta, an area of about 6,000 square miles economically dependent primarily on furs. The study is concerned with the production of mink and muskrat furs, which represent about 95 per cent, by value, of the furs produced in the area. Successful exploitation of the fur is closely associated with other local resources such as fish, an essential food for the native people and their dog teams, and wood, which is used either as fuel or as building material. Essentially, fish and wood provide the basic subsistence economy, and furs provide a cash income.

The general trend in the delta in the past decade has been toward smaller fur catches and the abandonment of trapping areas; combined with reduced use of local subsistence resources, this trend has lowered living

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standards at a time when the cost of living is rising sharply, resulting in an unstable local economy. The connecting link between local economic conditions and the fur trapping industry is not difficult to trace.

Since 1952 there has been a steady shrinkage in fur prices and a decline in the individual trapper's fur take. Inadequate methods of trapping have given the local product an unfavorable reputation in the fur markets and have restricted its use to trimming purposes when facing competition with high-quality fur from other parts of Canada. The inferior product has resulted in lower prices, which in turn have reduced incentive, with the consequence that the trapper's income is about one fifth of that of a decade ago. Supplementary income obtained from summer building projects in the area has encouraged native trappers to leave the trapping areas and live in villages. This has inevitably led to a dependence upon cash income for necessities, and the need for relief assistance during winter, when little employment is available.

This study points out that if steps were taken to develop a rational program of regional rehabilitation, the fur industry would be considerably strengthened and could take its place once more as a stable economic factor upon which the delta population could depend.

GROWTH OF FUR TRAPPING IN THE MACKENZIE DELTA

Commercial trapping by the native people dates from the etablishment of a Hudson's Bay Company's fur trading post at Fort McPherson in 1840. This post served the trappers from Old Crow on the Upper Porcupine River, from the Mackenzie River delta, and from the Arctic Red and Peel river areas, and continued to be the main centre of fur operations until the turn of the century. In 1912 the Company established a post at Pokiak Point opposite the present village of Aklavik, and in 1924 moved it to Aklavik.

The establishment of the Aklavik post in the heart of the muskrat territory of the delta emphasized for the first time the economic importance of the delta for muskrat fur. Prior to World War 1 the natives hunted marten, mink, fox and beaver; muskrat fur was unimportant.

At the beginning of the century muskrat skins had little commercial value; by 1914 pelts were worth 50 cents each, and for the period 1921 to 1929 the average price had risen to $1.31 per pelt. Such prices as these brought white trappers into the area, and they stimulated trapping as a commercial activity; steel traps and the .22 calibre rifle were introduced, but more important, the native people learned to trap more efficiently.

The depression of the 1930s brought an abrupt fall in the value of pelts to a low of 31 cents, but their value rose again until they topped the dollar mark once more in 1935. The greatest stimulus to trapping was the demand created during and after World War II. In 1942, the average price for muskrat had almost reached $2 per pelt; after this year the average annual price ranged from $1.20 to $2.75 with prices reaching $3 to $3.50 for prime extra large pelts.

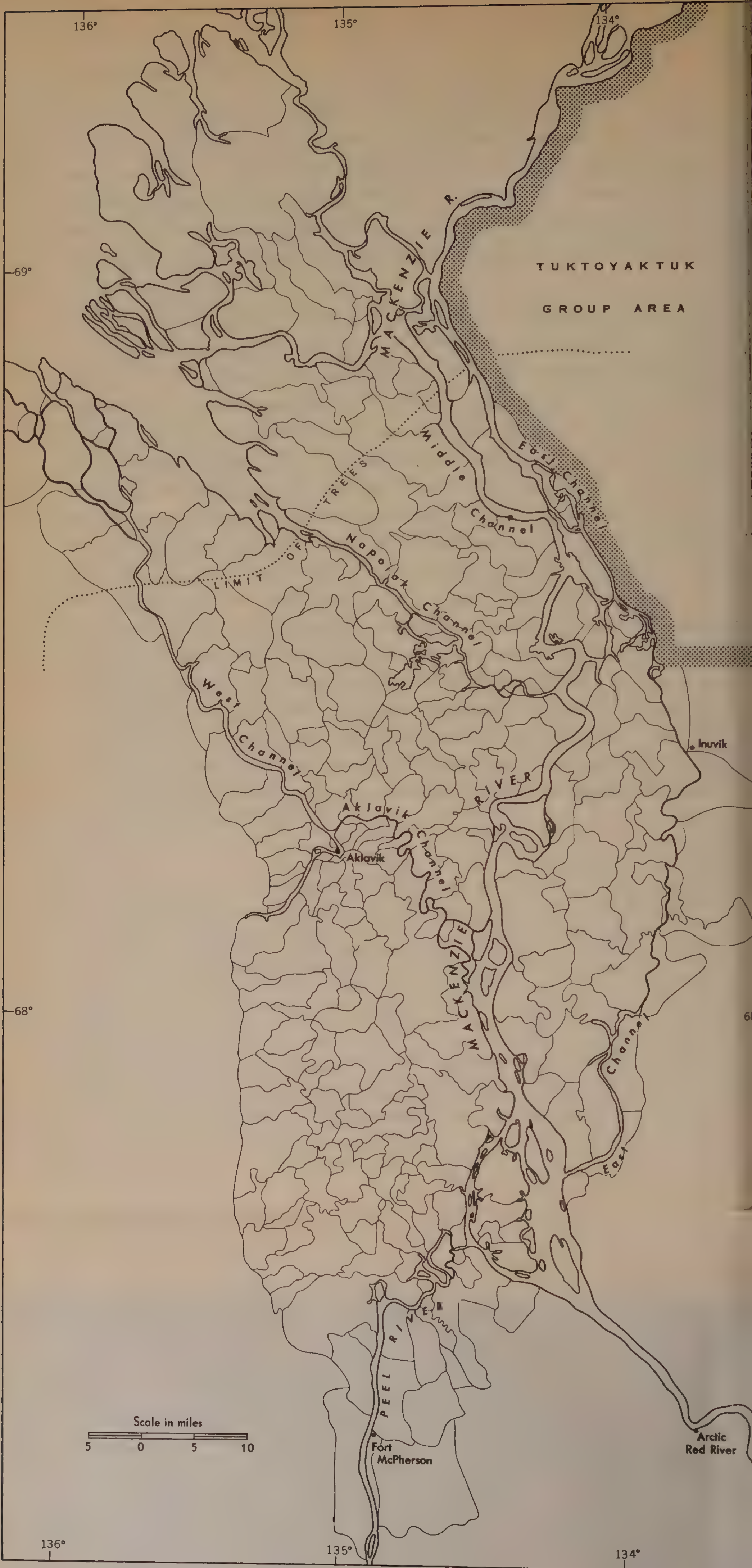
Trapping areas were gradually organized and the general rights of the Indian, Eskimo and white trappers to these areas were established. High prices for fur continued to bring an influx of trappers from outside the delta to take part in the spring muskrat hunt. Most of these were Alaskan Eskimos, and white and Indian trappers from the Territories. It was the practice of "outside" trappers and Fort McPherson trappers to roam over the whole delta; the latter followed the rising flood waters as far as Aklavik before turning back to Fort McPherson. This method of hunting was thought to reduce the amount of fur available. There developed a widespread fear that with high prices, a further influx of trappers would occur and that the muskrat population would be seriously depleted. By 1949, the delta was considered to be overpopulated by trappers—a condition that was serious from the fur conservation viewpoint, and one that undermined the economic stability of the area. An examination of the population figures at this time (Table 1), shows that the delta trappers represented about 28 per cent of the trapping population. The Territories contributed 37 per cent and the Alaskan Eskimos 20 per cent. At the end of the decade there were 287 registered trappers in the delta who, together with their dependents, accounted for a population of 1,265.

Table 1

Origin of Trappers, 1949–50[1]

Place	Mackenzie River Delta	Yukon and N.W.T.	Alaska	Other Areas	Total Trappers	Dependent Population	Total
Aklavik.......	46	101	36	33	216	714	930
Ft. McPherson	35	31	2	3	71	264	335
Total.......	81	132	38	36	287	978	1,265

[1] Data obtained from list of holders of registered trapping areas 1949–1950.


136°
135°
134°
69°
68°
TUKTOYAKTUK
GROUP AREA
MACKENZIE R.
Middle
Channel
East Channel
LIMIT OF TREES
Napoiak Channel
West Channel
Aklavik
Aklavik Channel
RIVER
MACKENZIE
Inuvik
East Channel
PEEL RIVER
Fort McPherson
Arctic Red River
Scale in miles
5 0 5 10

Registered Trapping Areas

In 1948–49, the registered trapping areas were blocked out by the local game warden with the assistance of members of the Mackenzie River Delta Trappers Association. The areas varied in size from 5 to 84 square miles, with the average area being about 23 square miles. The trapping areas resembled a form of Crown ownership and the trapper became a custodian of his area. On the whole there was general satisfaction with the plan, as it established the trapper's rights to his area more effectively. The registration of the trapping areas had certain important effects; it restricted the movements of the Fort McPherson trappers, and contained the delta trappers in their own areas. It discouraged "outside" trappers from coming into the delta, and fundamentally it provided for an adequate livelihood based on fur, through a sensible use of resources.

The new trapping areas were adequate in size when fur prices were high. However fur prices fell after 1952, and it was found that the areas were not large enough to provide an adequate livelihood, a situation unforeseen in 1948–49. By 1958–59, the system was considered to have outlived its usefulness and it was decided that the individual trapping areas should be united to form a single communal or group area. It was believed this system would raise fur production substantially and provide greater scope for individual trappers to increase their fur take. In the spring of 1959 many of the registered trapping areas of the delta were replaced by the group area. By July 1959, 35 per cent of the Aklavik trappers and 51 per cent of the Fort McPherson trappers had relinquished their registered trapping areas and had joined the Mackenzie delta group area.

The registered trapping areas, to many trappers, had possessed certain advantages over the group area. In the former the trapper had retained his personal interest in the care and conservation of his area. It embodied the trapper's basic idea of his personal rights to the area and the use of its fur, fish and wood resources. Lakes with a low fur population were left untrapped to allow them time for restocking. When mink fur was deteriorating in quality, many trappers preferred to leave such fur until the following autumn when it would become prime again. Most trappers carried out local improvements on their areas; other native trappers ceased hunting shortly after the end of May. Cabins for the trappers and their families were built in the

Figure 1. Registered trapping areas of the Mackenzie River delta, 1948-49, replaced in 1960 to provide for the establishment of family group trapping areas.

trapping areas, and trails and lines were maintained. Essentially the trapping areas came to resemble a form of private property on which the fur was farmed.

The open or group area removed the personal interest in conserving fur and resulted in the practice of shooting as much fur as possible without any regard for the local fur population or for the quality of the pelts. In order to get a share of the hunt many trappers joined the group scheme as they had been unable to police their own areas. The trappers retained exclusive trapping rights in the group area until May 1, after which they could hunt anywhere in the delta.

Both the open and registered trapping area systems possessed weaknesses that prevented the development of cohesive native family trapping units. In 1960, the trappers from Fort McPherson, Aklavik and Arctic Red River established a single trapping group from which it is expected that family group trapping areas should develop. This system of trapping areas provides for freer movement based on the availability of furs; furthermore, it is compatible with the native approach to the harvesting of fur resources.

THE FUR TRAPPING INDUSTRY

In the Mackenzie delta muskrat pelts are taken in the largest quantities and are followed in numbers by mink. The latter is the most valuable fur taken, but muskrat, although low-priced, provides the largest source of cash income for the native people.

Mink

The trapping season opens in the autumn with mink, and extends from November 15 to March 1. In the fall, with the advancing cold weather and long dark days, the mink pelt gradually turns from black to white, the latter being indicative of a prime pelt. In late autumn the pelt or skin may be 'spotty' and slow in turning prime.

The animal normally hunts close to lakes and streams and feeds on fish and young muskrat as well as on mice and rabbits. Because of abundant feed in the area, low temparatures and the long dark days of late autumn and early winter, the wild Mackenzie delta mink produces a fur of unusually high quality. The long guard hairs have a beautiful lustre, and a shade pleasing to the eye. The color of the underfur is blue-grey with a top coat of dark brown. The volume of fur is superior to that of other wild mink,

and in this respect, is equal in quality to the Labrador and Ungava wild mink both of which are synonymous with high quality.

The quality of the fur varies from month to month, and, as a result, fur values change (Table 2).

Table 2

Relationship of Monthly Change to Fur Values[1]

Items compared	Nov.	Dec.	Jan.	Feb.	Mar.	April	Total
Number of pelts......	29	242	198	185	59	14	727
Per cent of total......	4.0	33.2	27.2	25.4	8.1	1.9	99.8
Total value of pelts...	$577	$5,560	$3,934	$3,104	$904	$136	$14,215
Per cent of total......	4.0	39.1	27.6	21.8	6.3	0.9	99.7
Average value per pelt	$19.89	$23.00	$19.87	$16.77	$15.49	$9.71	$19.55

[1] The sample is based on 727 mink and the data provided by local fur traders.

Mink pelts are prime in the latter part of November and December. The quality of the fur becomes progressively poorer after the second week of January. About 20 per cent of the January catch is equal in quality to the December pelts. With increasing sunlight the ends of the guard hairs curl and have a singed appearance with considerably reduced lustre. Usually the pre-prime furs taken in November are superior in quality to the late fur. Mink are also easier to catch before Christmas, as they soon become trapwise. In terms of size, color and quality of fur, December is the month when choice quality pelts are available in greatest quantity. Most of the pelts, (73.6 per cent) taken in December are in the top price range exceeding $20 per pelt. As the value of March pelts is reduced to one-quarter of December values, many trappers prefer to leave the mink until the following season. The need for concentrated trapping effort from mid-November to mid-January in order to realize maximum cash returns when furs are prime is apparent, and it is also a standard principal in the wise use of resources.

The fur take varies widely among trappers, as indicated by Table 3 for the 1958–59 season. According to local estimates a take of 9 pelts constitutes a poor catch, 10 to 19 pelts is fair, 20 to 30 is good, and a catch of 30 pelts or more very good. There have been times when individual trappers have taken 50 mink in a season.

Table 3

Amount and Value of Mink Fur Take, Mackenzie Delta 1958-59

Number of pelts	Trappers		Fur take		Average trapper's catch		
	Number	Per cent	Amount	Per cent	Amount	Value[1]	Per cent
9 or less......	66	59	252	21	4	$ 78.00	4
10 to 19......	28	25	381	32	14	$273.00	16
20 to 30......	13	12	300	26	23	$449.00	26
Over 31......	5	4	240	21	48	$958.00	54
	112	100	1,173	100	10	$195.50[2]	100

[1] Data compiled from the fur returns by the holders of the registered trapping areas.
[2] The average value of the catch is based on an average price of $19.55 per pelt.

A large part of the low mink production is related to the number of daylines that are operated. (A dayline is a term given by trappers to a line of traps that can be visited by a trapper and his dog team in one day.) As the average number of trap lines per area is 3, most trappers maintain 1 to 3 lines and these are covered in one to three days. The lines with 10 to 30 traps are visited at weekly intervals. Most mink, however, are taken by the trapper who organizes his area in 3 to 5 daylines, each of which may be covered in about 3 to 5 hours. These trappers regularly set from 25 to 35 traps per line, and 2 to 3 traps at a setting where mink are known to exist. This schedule of operations leaves the trapper with two spare days. About 30 mink trappers operate from Aklavik; the farthest areas may require 2 to 3 days to cover.

One of the major reasons for cash loss to the trapper is the improper handling of mink pelts. Pelting and the preparation of skins are of major importance, as the amount of cash returns per pelt depends largely on the condition of the pelt. Well-handled prime pelts have glossy dense fur, they are clean in appearance, pliable, uniformly shaped, and free from grease. In the Mackenzie delta the most frequent fault is inadequate fleshing; it is estimated that about 70 per cent of the delta mink are prepared with flesh on the pelts. This condition leaves the fur greasy and matted, or causes decomposition of the pelt, resulting in a low-grade product. Over-streching or overdrawing of the fur gives the fur a thin appearance; the preferred practice is to permit the pelt to shrink slightly, in order to produce a heavy, well-furred appearance.

Mr. Arthur Look, game warden at Fort McPherson, points out that the auction prices shown below of a selection of poorly-handled pelts from the Mackenzie delta, and the well-handled furs from outside the delta emphasize the effect of quality upon price:

Category	1	2	3	4	5	6	7
	$	$	$	$	$	$	$
Well-handled........	62.50	55.50	51.00	40.00	28.00	26.00	21.50
Poorly-handled.......	31.50	27.50	—	—	—	—	13.00

Categories 1 to 7 are as follows: *1*. Dark males, extra large, extra dark to dark; *2*. Pale males, extra large, dark to part pale; *3*. Dark males, medium, dark to part-medium; *4*. Dark males, large, dark to part-pale; *5*. Dark females, large, extra dark to dark; *6*. Dark females, medium, dark to part medium-dark; *7*. Pale females, medium, dark to part-pale.

The trapping operation is marked by wide ranges in pelt production, in the price of fur and in the number of mink trappers (Table 4). The number of trappers engaged represents about half of those engaged in trapping muskrat; relatively few trappers systematically trap mink, and many of them put out only a few traps in the course of the winter.

Over a period of 30 years there occurs a 5– to 9–year cycle between one period of low production and the next. It is difficult to determine whether the low periods are related to scarcity of mink or to reduced trapping effort.

Table 4

Economic Aspects in Mink Production in the Delta Area, 1949–1959[1]

Year	Total Pelts	Average price per pelt	Gross value of pelts	Number of trappers	Average value per trapper
		$	$		$
1949–50..........	913	16.12	14,718	117	126.00
1950–51..........	1,403	22.05	30,936	165	187.00
1951–52..........	1,110	16.25	18,038	159	113.00
1952–53..........	1,140	16.03	18,274	135	135.00
1953–54..........	1,398	12.23	17,098	134	128.00
1954–55..........	1,010	15.02	15,170	115	132.00
1955–56..........	1,048	15.31	15,310	100	153.00
1956–57..........	613	13.65	8,367	76	110.00
1957–58..........	515	12.88	6,633	81	82.00
1958–59..........	1,173	19.55	22,932	112	205.00
Total........	10,323	16.22	167,476	1,194	140.26

[1] Information on number of pelts, average price per pelt and number of trappers provided by the Territorial Division, Dept. of Northern Affairs and National Resources, Ottawa. Average prices provided by Dominion Bureau of Statistics adjusted to meet local fur prices. For 1958–59 prices *see* Table 2.

Mink prices during the past 30-year period reached their maximum between 1945 and 1949; for the most part prices during the past decade have been about half the 1945–49 average.

Muskrat

The delta produces a muskrat fur that, because of its heavy, dense underfur, is particularly suitable for Hudson Seal garments. This quality results in part from the cold habitat peculiar to the delta. It is a smaller animal than the southern and eastern Canadian muskrat, and although it has fewer and shorter guard hairs, it is less uniform than southern muskrats, and in dyed garments does not provide enough lustre to emulate mink. As 80 per cent of national production of muskrat pelts is used to emulate mink, the delta product is at a serious competitive disadvantage. However, the pelts are sheared and dyed black to emulate the Alaskan fur seal and for wearability it is equal to other Canadian muskrat. The delta is a maze of shallow lakes and connecting channels that occupy from 20 to 60 per cent of the delta. The muskrat population breeds and winters in the lakes rather than in the connecting channels. The most suitable lakes are the locally called 'gassy' lakes, with beds covered with decaying organic material and with depths reaching 6 or more feet; they have gently sloping shores on one side and steep banks on the other for muskrat dens and burrows. The shores support dense meadows of *equisitum* or *arctophilia fulva* and *carex aquatilia.* Other water plants such as *potomageton* and *myriophyllum exalbescens*—the latter an important winter food—extend the feeding range into water 6 to 8 feet deep. Tunnels connecting the dens in the banks lead to the feeding grounds in winter. River channels have no feed and are therefore unsuitable for muskrat. With the beginning of freeze-up and the formation of ice over the lakes in October the muskrat pushes decaying vegetable matter through a hole onto the ice surface. The pushup, used as a feeding room, is enlarged in the course of the winter, and is connected by runways along the lake bottom to the feeding beds and to the dens in the lake banks. Frequent journeys of muskrat from the water to the pushup keep the hole in the ice open.

The marking of pushups is considered by the most successful trappers to be necessary in most seasons. They estimate that by so doing the muskrat

Figure 2. The maze of lakes and channels of the Mackenzie delta provide the physical foundation for muskrat trapping. (Reproduced from Sheet 107B, National Topographic Series 1:250,000, Surveys and Mapping Branch, Dept. M&TS (1961)).


Aklavik

fur take may be doubled or trebled. The number of pushups on each trapping area varies from 700 to 2,000 and in the larger areas may reach 5,000. Nowadays pushups are rarely marked, although trappers used to mark them in November or December with 3-foot lengths of willow or alder. Winter snow storms frequently cover the pushups which may not become visible again until the end of April when trapping is almost over. Preferred pushups usually lie 20 to 30 feet from the banks where the snow is deepest. In years of light snow or on wind-blown lakes a trapper may find only one-third of the pushups in use and the remainder frozen. The trap is set inside and when sprung the muskrat instinctively dives into the water and drowns. As many as 6 to 8 muskrats may be taken from a single pushup. About 30 per cent of the muskrat in the delta is trapped during the season from March 1 to May 28.

Certain climatic conditions affect the trapping operation. A heavy load of snow can depress the ice cover and flood the pushups, so that trapping on the lake ceases until a crust forms and the muskrats push through the crust to build a new pushup. In the warm or 'gassy' lakes open spots frequently exist in ice that may be 1 to 2 feet thick. 'Cold' lakes lack an organic-covered bottom, and these, together with sloughs with a few feet of water, freeze to the bottom, and provide unsuitable habitats. Drought also contributes to the forming of an unsatisfactory habitat because low water levels, combined with severe winters seriously reduce the number of muskrats by freezing, and it is not unusual to find 6 to 8 dead muskrats in a frozen pushup. Again, at high water during break-up in May the water in the small channels of the delta reverses direction and the lakes rise with the flood waters. The muskrats are driven from their dens and take refuge along the shore's edge where many of the young are drowned. Heavy freezing spring weather affects the fur take by reducing the number of traps that can be handled. In general, fur take decreases toward the Arctic coast and the eastern side of the delta.

The hunting or shooting of muskrats may start between May 15 and May 30 and varies from season to season. At this time the muskrat is hunted with .22 calibre rifles from 12- to 14-foot 'ratting' canoes. The first hunt is made when high waters begin to flood the lakes adjoining the river channels, and later is extended to the more distant inner lakes. Although daylight is constant at this time, the best hunting is done from 4 to 11 in the evening and from 3 to 6 in the early morning. The muskrats are usually quiet during

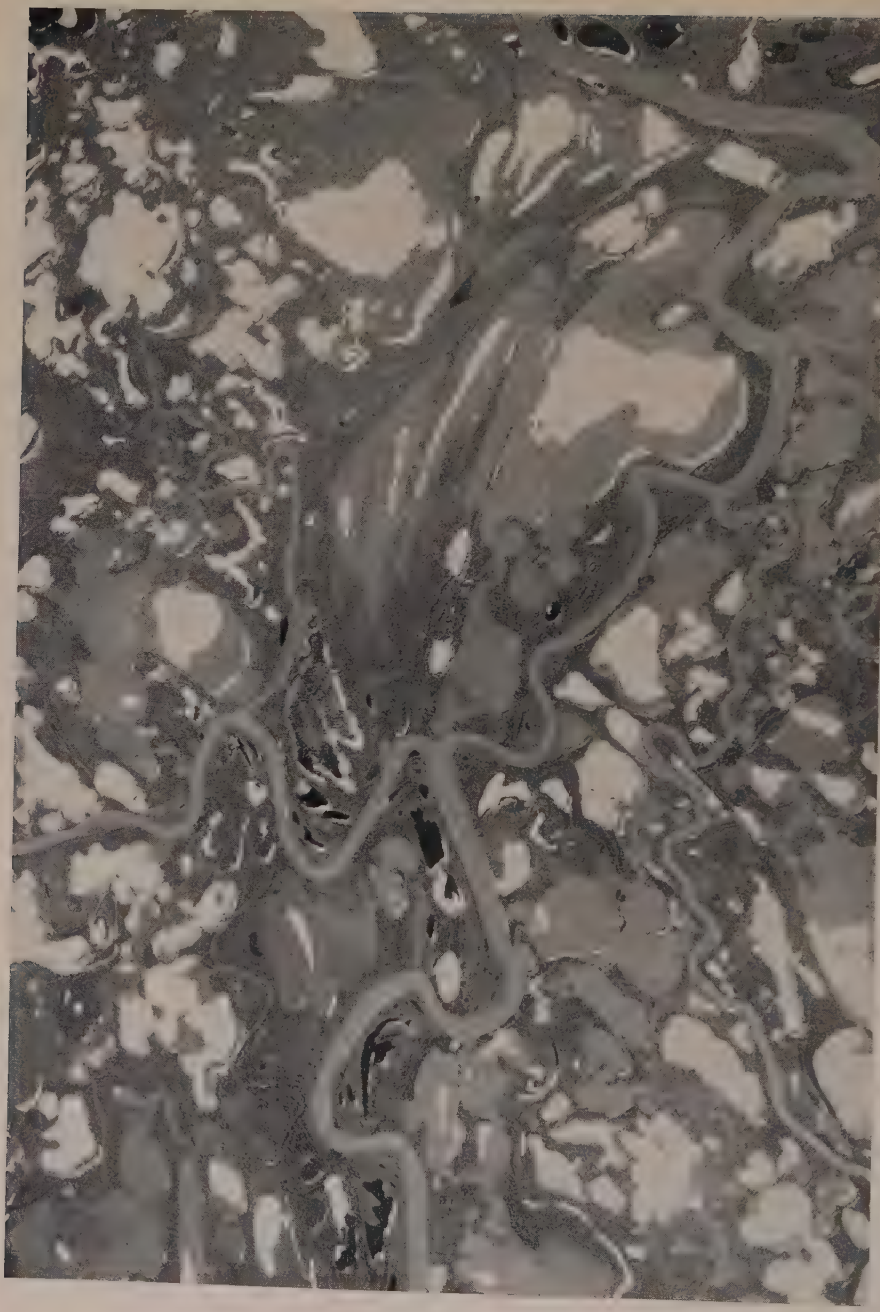


Figure 3

Part of the Mackenzie River delta, 10 miles northeast of Aklavik (June 11, 1952). As normal temperatures were prevalent during June, the ice remained on the lakes until about mid-June.

the midnight interval and during the daytime. During the flood-water stage and during the mating season after mid-May, they are readily approached by canoe; calling the muskrats brings first one then its mate out of hiding among the willows and they are then easily shot within a range of 10 to 30 feet. Early in June, after mating, the muskrats become wary and are difficult to catch. The importance of the spring shoot is shown by the fact that most of the fur is taken between May 28 and June 20. Much of the pelting is done by native woman; it takes about an hour to skin 30 to 40 muskrats and an hour to stretch the skins.

The grade and quality of pelts varies with the advance of the season and is reflected in the average price per pelt (Table 5). About 6 per cent by quantity and 5 per cent by value are taken between March 1 and March 27; these consist mainly of pre-prime or 'spotty' furs. Maximum prices are received for pelts taken between March 28 and May 28; this category accounts for 24 per cent by volume and 29 per cent by value and consists mostly of prime trapped pelts. Thereafter, the quality and value of pelts decline rapidly.

By this time the pushups have collapsed and the muskrats are forced into the open to feed so that the pelt changes color and the quality of the fur deteriorates. This condition is reflected in a lower average price per pelt. The average price paid for prime pelts of trapped animals is 77 cents; the average for shot animals is 58 cents, representing an average net reduction of 19 cents per pelt. Thus about 76 per cent of the total take is low-priced unprime and damaged pelts.

Table 5

Number and Value of Muskrat Pelts at Regular Intervals, 1959
(Data provided by fur traders)

Item compared	March 1 to March 27	March 28 to May 28	May 29 to June 15	After June 15	Total
Number of pelts	2,809	11,068	11,050	21,106	46,033
Per cent of pelts	6	24	24	46	100
Value of pelts	$1,578	$8,509	$6,538	$12,459	$29,084
Per cent of value	5	29	23	43	100
Average price per pelt	.56	.77	.59	.59	.63

The distribution of muskrat pelts by price range, (1959) in terms of the number and value of the pelts, is shown below, based on data provided by local fur traders.

Value per pelt	.20	.30	.40	.50	.60	.70	.80	.90	1.00	Total
Number of pelts	22	208	919	6,646	24,487	5,048	2,050	3,021	170	42,571
Value of pelts	$4.40	$63	$367	$3,323	$14,692	$3,534	$1,640	$2,719	$170	$26,512

The distribution illustrates that 76 per cent by volume and 68 per cent by value are within a price range of 20 to 60 cents per pelt, and only 24 per cent by volume and 32 per cent by value exceed 70 cents. It emphasizes that in the main the trappers are producing a low-valued product.

The relationship of fur production, in terms of the duration of the open season to the range in the value of pelts, is given in Figures 4 and 5. March production consists mainly of pre-prime, lower priced pelts, whereas April and May production consists mainly of prime trapped pelts. About 70 per cent of production, concentrated in a 3- to 4-week interval near the end of the season, and falling into the 50-cent and 60-cent class, consists of damaged pelts. Thus the cash value and quality of production is closely related to the advance of the open season.

The low prices for muskrat fur, as for mink, result from poor handling of the pelts and vary with the individual trapper. The most frequent faults are badly fleshed pelts, sunburned pelts, grease-burned and rancid pelts. During the rush of the spring shoot, skinning is often delayed and the pelts deteriorate and tend to shed fur. Great damage is produced by gunshot holes and bullet burns. Much more serious is the damage incurred by fighting among the animals during the spring mating season. Pelt damage begins about mid-May and extends to about mid-June. Some native women sew up the tears, a practice that improves the appearance of the pelt, but all skins taken after mid-May are damaged, and are graded according to the extent of damage. Since the spring shooting season in the delta is longer than in other areas, more badly damaged skins are taken in the delta.

Three-quarters of trapped muskrat pelts are badly fleshed, which reduces their value by half. More than half of the shot pelts are worth 25 per cent less than the prime trapped pelts. Animals shot after the first week in June are further reduced in value owing to shedding. The damaged furs do not depress the market, but do reduce the average value of the product, as damaged pelts are used mainly for trimming purposes. The principal result of producing badly handled pelts is that the prices are about a third to a half of prices for well-handled furs.

THE GRADING AND MARKETING OF FURS

The grading of pelts as a means to raise the standard of the delta product is of relatively recent origin. Prior to World War II pelts were purchased on the basis of an average price without regard to quality, but

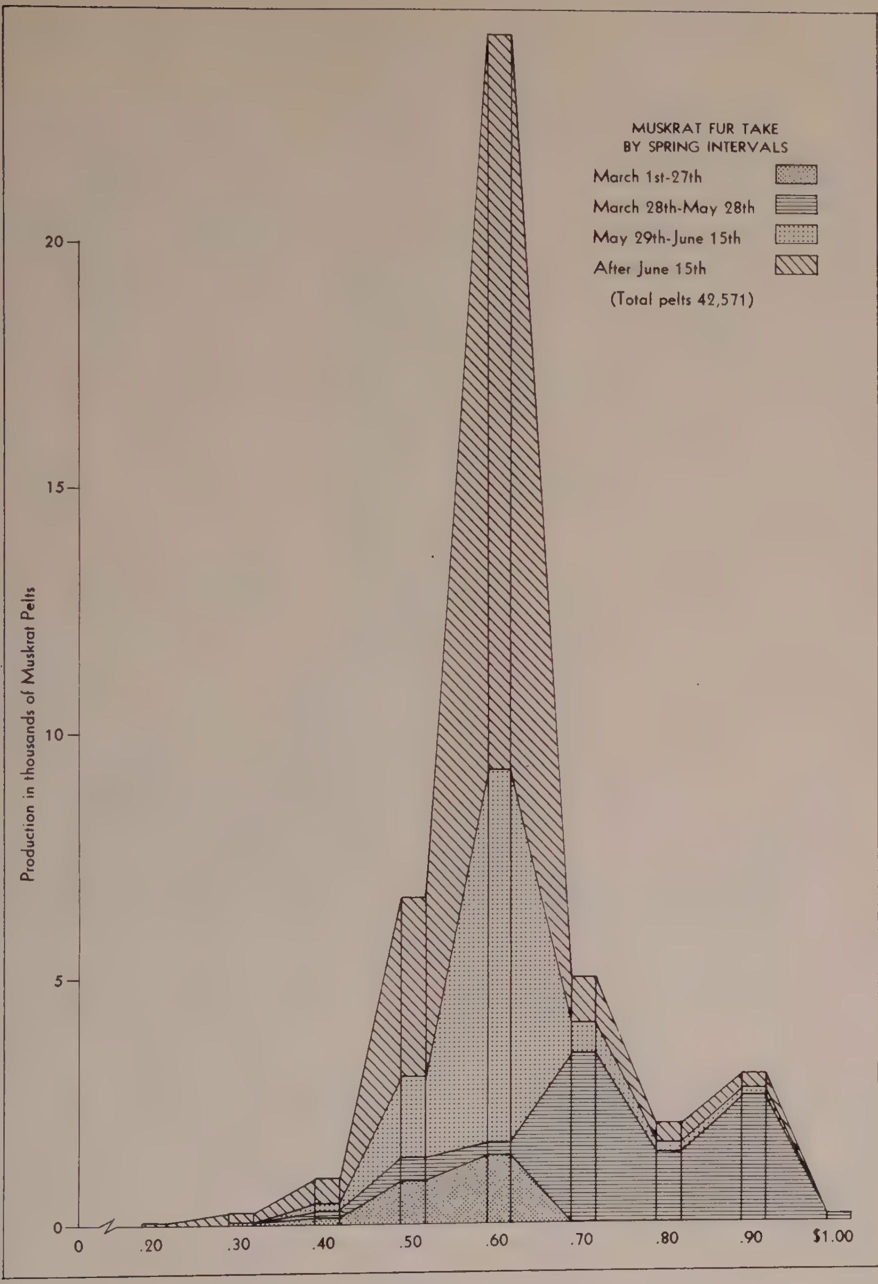


Figure 4.

Distribution of muskrat pelts by price range, Spring 1959. Data provided by fur traders.

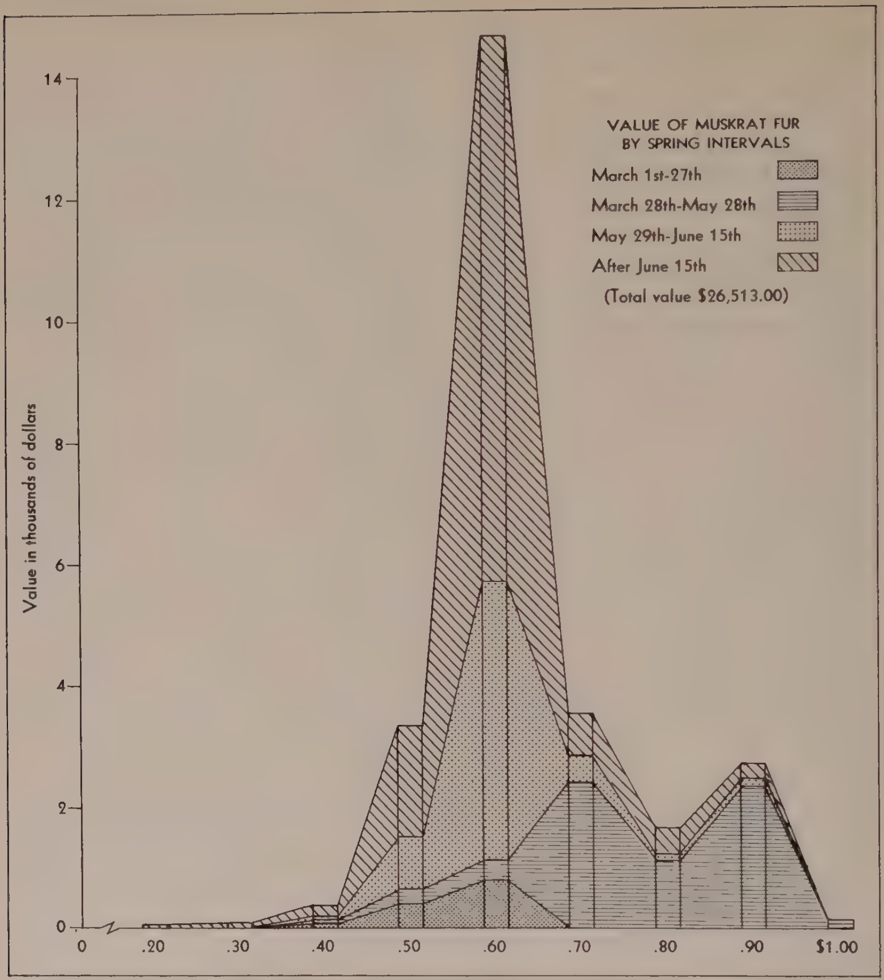


Figure 5.

Value of muskrat pelt production by price range, Spring 1959. Data provided by fur traders.

during the war grading began and was gradually extended with rising fur prices. The rapid fall in fur prices during the 1950s and the change to cash business favored the use of grading as a basis for the purchase of furs. Traders used to buy 'green' or uncured pelts for 15 to 20 cents less per pelt and cure them. Because of low prices in which the profit margin was reduced this practice ceased about 1952. Muskrat pelts are graded locally as trapped or as shot pelts; the trapped are graded as follows: extra large, large, medium and small; the shot pelts are graded according to the extent of damage: head wounds, body wounds, bullet burns, and bad damage. A

considerable quantity of furs are sold by the trapper on the basis of an average price for the lot, provided that not many are badly damaged. As good and poor pelts can be purchased at an average price, there is no incentive to produce a well-handled pelt. With the fall in prices, credit to the trappers also fell, until amounts of less than $200 were extended. In the previous decade high prices frequently permitted credits up to $1,000 or $2,000 which were taken out in merchandise and eliminated the general use of money. With such large credits extended to trappers by traders, fur buyers were not allowed to buy furs in the Territories; it was necessary to assure traders that on the granting of credit, furs would be marketed through them. Instead of counteracting the declining trend in fur prices by increasing production and by producing a well-handled product, the native trapper tended to lower the amount of his catch and to produce a low-grade product. Thus, on the whole grading did not result in an increase of prime pelts.

The production of a low-quality product, resulting in low cash returns is borne out by the going prices for the Mackenzie delta muskrat at the fur auction (Table 6). The traders' risk increases with lower prices, as profit margins become narrower. As long as traders continue to accept a low-standard product and find a market for it, there will be no incentive for the native trapper to produce a better product. Yet with a little extra care at the various levels of the trapping and pelting operation the trappers could readily turn out a well-handled product. Arthur Look, game warden at Fort McPherson, has been demonstrating improved techniques in the handling of furs to native trappers. The essential fact remains that sustained production of a low-quality product has resulted in continuing low income for the trappers.

Table 6

Charges in the Marketing of Muskrats per Pelt[1]

Year	Average cost price	Average selling price	Handling charges[2]	Average net price	Profit
1955	.86	1.12	.15	.97	.11
1958	.45	.60	.09	.51	.06
1959	.63	.79	.09	.70	.07

[1] Based on fur consignments exceeding 20,000 pelts shipped by the trader to the fur auctions.

[2] Handling charges per pelt for 1958 and 1959 consisted of: commission 3.8¢, freight 2.2¢, royalty 2¢, and local handling 1¢. In 1955, the royalty fee was 5¢.

In grading, the general practice is to raise the value of the shot pelts and to lower the value of the better quality fur in order to cover the low prices that are likely to be obtained for damaged furs at the auctions. A comparison between local fur prices and auction prices indicates local prices for damaged furs are higher than those obtained at the auction sales.

The frequency of fur deliveries to the local traders is shown in Table 7. Of a total of 46,023 pelts, 6 per cent were delivered between March 1 and 27; 24 per cent between March 28 and May 28; 24 per cent between May 29 and June 15, and 46 per cent after June 15. About one-third of the pelts delivered were in lots of 19 or less, indicative of the prevailing native practice of day-to-day living. The common pratice is for most native trappers to deliver the fur to the trader as soon as a small number of pelts are cured. Only a few trappers deliver furs in amounts exceeding 200 pelts.

Table 7

Frequency of Muskrat Pelt Deliveries, by lots 1959

Spring interval	<19	20–49	50–99	100–199	200–499	>500	Total
March 1–27	49	22	7	7	1	—	86
March 28–May 28	158	98	48	18	4	—	326
May 29–June 15	65	71	67	27	7	—	237
After June 15	19	53	43	50	27	5	197
	291	244	165	102	39	5	846

Most traders pay cash for furs, but may exchange furs for merchandise, in which event they give higher value. There is very little difference in the purchase price of muskrat furs among the traders, but the price of mink varies from $1 to $2 above or below the monthly average. Keen competition for furs results in higher returns to the trapper. Where there is competitive buying, prices tend to seek proper local levels with respect to the going prices at the fur auctions. Only about 5 per cent of the trappers dispose of their entire production to one trader.

Indebtedness does not confine a trapper to any particular trader. Credit is usually granted at the beginning of the fall fishing season and after the New Year; another advance is issued at the beginning of the muskrat trapping season or at the beginning of the spring hunt. No credit is

granted in summer; general indebtedness is usually paid off after the spring shoot. For many of the native trappers, fur production would practically cease without credit extended by the trader.

As the trader's profit averages 6 or 7 cents a pelt at the fur auctions, there is little reason for the trapper to bypass him. This is particularly true in the delta as furs are delivered in small amounts and prices are low; the shipping of furs in small amounts to the fur auction is not practical.

Furs are delivered to the fur auctions from the producing area, either through the Hudson's Bay Company, through private traders or direct by the trapper. The proportion marketed by each of these groups is shown in Table 8. Only about 10 per cent of the mink and 7 per cent of the muskrat are shipped direct to the auctions by trappers, but these are the choicest quality, the poorer grades being sold to the local buyers. The Hudson's Bay Company, through its northern stores, purchases furs direct from the trapper to be marketed at its fur sales in Montreal, or in New York or London fur markets if prices are more attractive. Most trappers and traders ship furs to the various auctions that are held in Winnipeg, Edmonton and Vancouver from January to August. The fur companies solicit fur consignments and sell at auction on a 5 per cent commission basis.

Table 8

Fur Exports from Mackenzie River delta 1959[1]

Item	Private		Traders		H.B.C.		Total	
	Amount	%	Amount	%	Amount	%	Amount	%
Mink.......	133	10	876	64	354	26	1,363	100
Muskrat....	7,764	7	64,205	58	38,222	35	110,191	100

[1] These amounts only include the furs that are disposed of through the fur auctions. Data compiled from Fur Export Records, Territorial Division, Dept. of Northern Affairs & National Resources, Ottawa.

Prior to the auction the fur is cleaned, and its appearance improved; it is not presentable to buyers in the condition in which it arrives. It is then graded and sorted into lots of various sizes. A catalogue containing a description of the fur according to lots is prepared before the date of the auction. The market price of the fur is determined from bids placed on the floor by representatives of the fur industry.

One of the main problems for the industry has been the irregular volume of furs received from native trappers. As long as the white trapper continued to work the traplines regularity of production could be assured. The most dependable native catches came from those trappers who remained in their areas and trapped systematically. Trappers, however, are most sensitive to price changes in furs and to alternate employment. With falling prices in the industry, the white trapper and many native trappers turned to more remunerative employment, resulting in widespread reduction in the fur take. This has resulted in unstable supplies to the manufacturers and in turn has retarded the rise in fur prices.

Muskrat is the basic fur of the industry; its major advantage being that it can be cut and dyed to emulate the numerous shades of mink, although only about 10 to 15 per cent of delta muskrat production is suitable for this purpose. There is little demand for natural muskrat.

TRAPPER INCOME

Certain economic aspects of fur production, such as the number of trappers, and fur prices for the period from 1950 to 1959, are shown in Table 9. Wide ranges in annual production occur. The lowest annual yield of 80,642 pelts is associated with the lowest average price (31 cents); with one exception, maximum yields were associated with top fur prices. The

Table 9

Economic Trends in Muskrat Production in the MacKenzie Delta, 1950–1959[1]

Year	Total pelts	Average price per pelt	Gross value of pelts	Number of trappers	Average value per trapper
		$	$		$
1950...	160,924	.78	125,520	307	409
1951...	234,318	1.31	306,956	394	779
1952...	283,924	1.11	315,155	405	778
1953...	173,964	.62	107,857	371	291
1954...	177,278	.43	76,229	377	202
1955...	241,594	.47	113,549	386	294
1956...	161,598	.50	80,799	377	212
1957...	99,537	.49	43,873	280	157
1958...	80,642	.31	24,999	238	101
1959...	114,068	.63	71,960	177	406
	1,727,847[2]	.73	1,266,897	3,312	382

[1] Information on fur statistics, except for 1959, provided by Territorial Division, Dept. of Northern Affairs & National Resources, Ottawa. Average prices provided by Dominion Bureau of Statistics adjusted to meet local prices. For 1959 prices *see* Table 5.

[2] Muskrat fur returns for 1960 were 63,956 pelts; this catch is the lowest since record-keeping began after World War I.

general trend in the amount of income received by the trapper has been downward over the past 10 years, partly related to the market price and quality of pelts, but also related to quantity production. Of some 233 registered muskrat trappers in 1959 only 147 took muskrat. The overriding result of continued low prices, low fur production, changes in living habits, and the steady rise in the cost of living is that the trappers in the Mackenzie delta are faced with an economic recession.

The lowest number of active fur trappers occurred in the years following 1957, and is largely related to the construction program at Inuvik. In 1957 this project drew 231 persons from Aklavik and Fort McPherson, and this number has increased annually. One serious effect of this program has been an increasing withdrawal of a large part of the population from the fur trapping areas, to settlements, and a consequent falling off in trapping.

Thus, in addition to loss in value through poor processing methods there has been loss through inadequate trapping. Wise harvesting of muskrats would result in full annual yields of pelts and of choice natural furs. Areas poorly trapped produce overpopulation that results in pelts that are smaller and often of poor quality. Adequate trapping produces a better adjustment between population and food supply and in addition tends to check the spread of *taenia mustellae*[1] and disease epidemics with attendant lowering of the quality of the fur. In 1959 about one-tenth of the delta area was adequately harvested, five-tenths was poorly harvested and the remainder was unharvested. In the previous decade, with heavy production of pelts, an untrapped area acted as a nursery for the adjoining areas. The major trend, therefore, is towards reduced use and abandonment of the fur trapping areas, and, at a time when the immediate trend in muskrat population is towards greater abundance.

There is considerable controversy on the merits of shooting and trapping muskrat, most of which is centred on the view that muskrat populations are not depleted by shooting. The leading trappers indicate that the trapping of muskrats is practical as the lakes are ice-covered for

[1] Personal communication from Dr. Everett Schilla, pathobiologist, Johns Hopkins University indicated that liver infestation from this tapeworm in 1959 would be fatal to about 20 to 25 per cent of the delta muskrat population. It is difficult to discover from production figures those years when the die-out cycle of muskrats was significant. Between the summits of widespread die-out and widespread distribution of muskrats local pockets of infestation occur throughout the delta area. The infestation is reported to possess a seven-year cycle. Ingestion by mink of infected muskrats perpetuates the cycle.

11 weeks of the 15-week season, and aim to have a quarter to a half of their fur in trapped pelts. Trappers who reside in their areas take a higher proportion of trapped pelts. A large number of trappers, particularly the less productive ones, wait only for the spring hunt. The advantage lies mainly with the trappers residing on the areas.

Low average income per trapper indicates that a large part of the trapping population is producing less than the community average; the amount and value of furs taken among the trappers also varies widely from year to year (Table 10). About 43 per cent of the trappers (69) take about 11 per cent of the furs produced in the delta in amounts of less than 350 pelts per trapper; about 52 per cent of the trappers (84) account for

Table 10

Amount and Value of Muskrat fur-take by trapper 1959[1]

Number of pelts	Trappers		Fur take		Trapper's catch[2]		
	Number	Per cent	Amount	Per cent	Amount	Value	Per cent
Less than 150	35	22	2,797	3	80	$ 50.	2
151 to 350	34	21	8,543	8	251	$ 158.	6
351 to 700	45	28	23,026	22	511	$ 322.	14
701 to 1,400	39	24	52,605	51	1,348	$ 849.	33
Over 1,401	9	5	16,633	16	1,848	$1,164.	45
	162	100	103,604	100	639	$ 403.	100

[1] Data compiled from the fur returns made by the holders of the registered trapping areas.

[2] The average value of the catch is based on an average price of 63 cents per pelt.

almost half the furs produced. According to local estimate, a catch of 700 pelts or less is poor; 700 to 1,400 is fair, and over 1,400 pelts is good. Each year there are a number of trappers whose catch exceeds 2,000 pelts. In terms of gross cash returns, only 5 per cent of the trappers approach an income of $1,500 which, the leading trappers claim, can be produced from an adequately stocked trapper's area.

On the basis of the 1958-59 average fur prices, a combined catch of 2,000 muskrats ($1,260) together with 30 mink ($586.50) provides a cash income of $1,846.50.

DEVELOPMENT OF SPECIALTIES

Although no specialties have developed in the Mackenzie delta area, mink ranching could be a logical development. Mink ranching in Canada, which began in the mid-1920's, was brought about mainly through the demands of the market as wild mink supplies were insufficient. At present wild mink pelts account for about 10 per cent of the 900,000 mink produced in Canada, with farm production doubling in the past 5 years. An aspect of specialty development would be to combine the desired qualities of domestic mink with the desirable qualities of the wild Mackenzie delta mink in order to produce a unique regional product. Such a product was developed over a period extending from 1946 to 1955. The strain of mink was unique and previously unknown in Canada; the fur was beautiful, of pleasing color effects and of excellent quality; the pelts retained the large size, blue-grey undercoat and fine-textured fur of the wild Mackenzie mink. Ranch-bred stock introduced pastel shades and the strain that made the mink satisfactory for domestication purposes. The ranch ceased to operate in 1955.

Certain aspects of this operation are shown on Table 11. The following points should be noted: the steady annual increase in the number of adults; the substantial number of surviving young; the annual yield of pelts amounting to more than one-third of the total stock and operating expenses of about $2,000 per year. The ranch demonstrated that with the help of native labor mink ranching in the delta was economically sound, and that the natural environment was particularly suitable for mink raising.

Table 11

Ranch Mink Production 1947–55
(Data supplied by F. L. Semmler)

Items compared	1947	1948	1949	1950	1951	1952	1953	1954	1955
Adult mink	128	94	324	439	596	429	645	688	496
Surviving young	100	284	393	520	403	621	636	456	285
Total mink	228	378	717	959	999	1,050	1,281	1,144	781
Fur losses	—	11	23	58	75	37	42	40	17
Mink pelted	—	43	255	304	455	368	551	608	485
Per cent of pelts to total mink	—	11	35	32	45	35	43	53	62
Operating expenses	$3,200	$3,380	$1,584	$2,416	$2,602	$2,122	$2,155	$2,098	$1,834

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The experimental stage of a fur garment industry at Aklavik conducted by the Education Division of the Department of Northern Affairs and National Resources in 1959, has proved successful. The native women, adept at matching furs, and in finishing, showed a 100-per-cent improvement in their work over a six-month period. A variety of specialized products is possible in furs, needlework, bead work, moose-suede jackets and ceremonial garments.

The success of the experimental garment industry suggests that a local tanning industry would be practical. Fixed charges associated with the processing of a select number of furs are itemized below, based on information supplied by Ernest Latour, director of the fur garment industry in Aklavik.

Number of pelts	Purchase price of pelts	Shipping charges	Tanning charges	Royalty export fee	Total cost	Per cent of fixed charges to total cost
400	$360	$150	$120	$8	$638	43.6

Shipping and tanning charges, and royalty export fees amount to $278 or 43.6 per cent of the total cost of preparing 400 muskrat pelts. So far, the experimental industry has produced only natural muskrat garments, which have a limited market. To widen the market, a dyeing operation should be added. Arthur Look, Fort McPherson, states that costs for the production of a full-length, 7¼-lb Hudson Seal coat with hood are:

Cost of 84 pelts	Tanning	Making of garment	Dyeing of garment	Provincial sales tax	Royalty export fee	Express charges	Total cost	Per cent of raw fur cost to total cost
$84	$33	$170	$20	$19	$1.68	$29.20	$356.88	23.5

Almost one-third of the costs are in the dyeing, taxes and express charges, and almost half the cost in the manufacture.

The primary advantage of this project is that it gives employment to natives who are unable to trap and hunt. In addition the cost of production of any garment is self-liquidating on its sale. The experiment has proved that a garment industry is feasible.

CONCLUSION

In the Mackenzie delta the economic trend is towards reduced use of the basic fur resources, and abandonment in some areas, even though fur trapping is the backbone of economic activity in the delta. Returns from furs are no longer sufficient to renew equipment or to provide an adequate livelihood. Local harvesting methods give rise to low-quality furs with attendent low prices, in the face of which the native trapper has tended to reduce his fur take. Native trappers have rarely received practical assistance in the proper methods of handling pelts, because these adverse conditions arose after a long period of prosperity that came to an end about 1952. It is mainly in the last decade that serious economic conditions affecting the lives of the people have developed and as a result, active steps are being taken by the federal government to alleviate this situation.

In recent years there have been other contributing causes that seriously affected the production and quality of furs. Community living tended to discourage adequate maintenance of the traplines and to reduce the amount of time for trapping because of distance from the trapping areas. Summer employment on the DEW-line sites and at Inuvik has on the whole not been successful. With high wages the natives have tended to concentrate in the villages, which has resulted in reduced fur take, to be matched by increased expenses arising from community living. The movement to the villages has also reduced the spirit of independence that is compatible with the trapper's way of life. The replacement of the registered trapping areas with the group area can only foster the continued production of a low-grade product, as personal interest and personal conservation practices are eliminated. Finally, as long as traders continue to find a market for a low standard product, incentive is not likely to be strong for producing a superior pelt.

The most pressing problems are need for rehabilitation of the trapping areas; renewed production of high quality pelts; adequate utilization of subsistence resources; and the development of local specialties. The successful solution to these major problems is an economic necessity, both for the welfare of the local population and the continuation of fur production as an important cash resource. Upon its achievement hangs the basis for the establishment of a sound, stable, local economy.

The writer acknowledges the assistance of trappers and traders; and thanks H. R. Conn, Dept. of Citizenship and Immigration, Ottawa, and Dr. E. P. Weeks, Dept. of Public Works, Ottawa, for reading the manuscript.

FORT McPHERSON, N.W.T.

W. E. S. Henoch

ABSTRACT: A geographical appraisal of Fort McPherson is presented in the light of potential economic and cultural changes that may result from the future development of the area. The settlement, situated on Peel River within the Mackenzie River delta, has a population of 453, the majority of which are Loucheux Indians whose livelibood depends upon hunting, fishing and trapping. The physical characteristics of the site are described, including terrain features, climate and freeze-up and break-up of the rivers. The pattern of settlement and the various types of dwellings, public and commercial buildings are discussed. Cabins used by trappers during their seasonal migration between Fort McPherson and the surrounding trapper areas are located.

RÉSUMÉ: Cet article donne une estimation géographique de Fort McPherson tout en envisageant les changements qui pourront s'opérer tant au point de vue culturel qu'économique, résultat du développement futur de cette localité. Cet établissement, situé sur la rivière Peel dans les confins du delta du fleuve Mackenzie, compte une population de 453 habitants. La majorité des indigènes sont des indiens Loucheux qui comptent sur la pêche, la chasse et le piégeage pour subvenir à leur subsistance. Les traits physiques tels les accidents de terrains, le climat, le gel et la débâcle sont mentionnés. Le plan de cet établissement, les genres variés d'habitation, les édifices publics et commerciaux sont étudiés. Les cabanes, dont se servent les trappeurs durant leur migration saisonnière entre Fort McPherson et les régions de trappe environnantes, sont indiquées.

In recent years extensive mineral explorations have been carried out on the Peel River plateau and in the lower Mackenzie River area with positive scientific results. To assist the development of the area, a road from Flat Creek near Dawson was surveyed to Fort McPherson and the beginning of construction planned for 1959. The realization of these projects will bring rapid cultural and economic changes to Fort McPherson, a settlement of trappers, fishermen and hunters. The purpose of this paper is to present the geography of the settlement, based on observations and data gathered mainly in the summer of 1958 (Figure 1).

Exploration

When John Franklin was returning from his second expedition (1825–1828) the party mistook Peel River for Mackenzie and travelled up its course for a considerable distance. Franklin (1828) named the river after Sir Robert Peel and advised the Hudson's Bay Company that the area was rich in furs. In 1839, the Company sent a trader, John Bell, who explored Peel River to Snake River. The first Hudson's Bay Company post on

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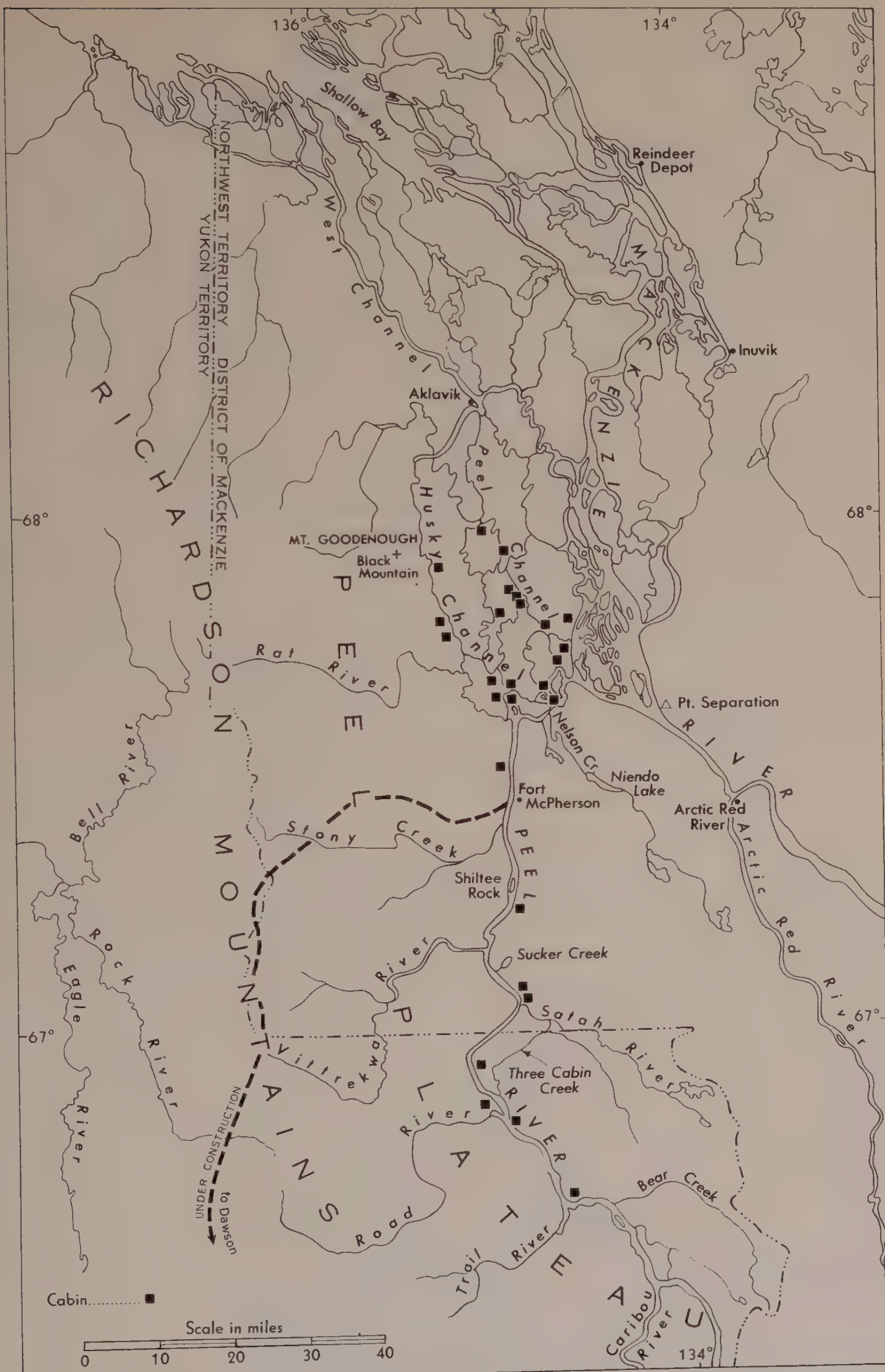

Figure 1. General map of the lower Mackenzie and Peel River area. Cabins are located within the survey area.

the Peel was established in 1840 by Bell and Isbister (Isbister 1848), and in 1848 it was named after the Chief Trader of the Hudson's Bay Company, Murdoch McPherson. Prior to the establishment of this post the natives traded at Good Hope, 200 miles away. In 1852, an Indian village, situated on the bank of Peel River opposite Stony Creek, was moved to the present position of Fort McPherson. Apparently the main reason for the move was that the terrace on which the old settlement was located was frequently flooded in springtime; the usual reason given by the Indians is that they moved to the present site because it commands an excellent view of the delta, and thus gave the advantage of an early warning of the approach of enemy Eskimo. It is known that from 1849 to 1859 the local Loucheux Indians were engaged in frequent feuds with Eskimos. Reflecting this, one of the lakes in the area is called Lake of the Stolen Nets.

According to Anglican parish records the population of the area in 1871 consisted of 351 Loucheux Indians and 300 Eskimo. Later, probably due to a decline in the fur trade, Fort McPherson lost its attraction for the Eskimo and they moved farther north to the Aklavik area; today, the only inhabitants of Fort McPherson are Loucheux Indians.

Fort McPherson, although isolated lay on the survey routes of many famous explorers. Ogilvie (1891), during his exploratory survey of Lewes, Porcupine, Bell, Peel and Mackenzie rivers, stopped at Fort McPherson in 1888, arriving there through MacDougal Pass. In the same year, the post was visited by McConnel (1891), who crossed the Richardson Mountains from Stony Creek. In 1893, Sainville visited Fort McPherson when he mapped Peel River to Wind River. Camsell, in 1905, travelled from Dawson via Wind River, Nash Creek and Peel River to Fort McPherson and the Mackenzie; he returned to Fort McPherson and then travelled via Rat River and McDougall Pass to Dawson (Camsell 1906).

In 1906 the parties of Stefansson and Stewart met in Fort McPherson and continued together on part of their trails to Richardson Mountains (Stewart 1913). Stefansson gives an account of the hospitality he received in McPherson during his later expeditions in 1907 and 1908 (Stefansson 1922, 1951).

The first white people to cover the whole length of Peel River were five prospectors who, in 1900, travelled north across the mountain divide

from Chandindu River, and descended the Peel River believing that they travelled on the Stewart River; they discovered their mistake only on reaching Fort McPherson.

The first known missionary was a Roman Catholic priest, Father Grollier who, it is recorded, baptized 65 persons in Fort McPherson in 1860. In 1895, he moved to Arctic Red River with a number of Indian families. The Anglican Mission was established in 1860 and today the entire Indian population belongs to this church. The Roman Catholic Mission was built in 1943. As the main part of the parish is in Arctic Red River, the priest travels between the two localities by motor boat.

Site

Fort McPherson, at 67°27' north latitude and 134°53' west longitude, is situated on an isolated flat-topped hill on the east bank of Peel River (Figure 2). The hill, rising 150 feet above sea level, and commanding an excellent view of the surrounding area, is about a mile long and half a mile wide and trends from north to south. It is surrounded by the Peel River alluvial plain which is characterized by many swamps, lakes and channels. For all practical purposes Fort McPherson is situated on an island, accessible during the ice-free months only by boat, float-equipped aircraft or helicopter. The hill is a part of the Mackenzie plain, and was carved from it by the ancient Peel River and its tributaries which flowed at a higher

Figure 2

The site of Fort McPherson, looking northwards. (RCAF photo, 1930).

level than the present rivers. The plain slopes gently northward from a height of 200 feet above sea level to 100 feet in the proximity of the delta. A few hills rise above the plain to a height of 400 feet along the winter trails from Fort McPherson to Arctic Red River and a narrow strip of the plain stretches west of the Peel River from Shiltee Rock to Husky Lake. Looking westward from McPherson, the Peel plateau can be seen rising from the plain in several well-marked terraces.

The Mackenzie plain was covered by the continental ice sheet which extended over Peel plateau in some places to the foot of Richardson Mountains (Bostock 1948, p. 37). During the retreat of the ice sheet the plain was dissected by numerous meltwater channels which usually followed channels of the pre-glacial drainage pattern. Post-glacial erosion is characterised by short, V-shaped valleys. Southeastward from Fort McPherson, abandoned channels of Peel River appear as prominent features along its west bank, and have the form of steep-sided valleys about 100 feet deep and several hundred feet wide. The floors of most of these valleys are flat and covered by alluvium, but some are suspended above the recent alluvial deposits of Peel River.

The underlying rocks in the Fort McPherson area are marine sediments of Cretaceous age. Shale is exposed on slopes and in the quarry at Fort McPherson, but is commonly covered by clay and silt with occasional boulders of glacio-fluvial deposition. It is grey, soft enough to be excavated with a mechanical shovel, and is used for the surfacing of roads in the settlement. When saturated with moisture, however, it disintegrates rapidly. When used for roads it is placed on fascine in a layer 3 feet deep, and is graded to provide good drainage. Fortunately there are only a few vehicles in Fort McPherson. Shale is found at an average depth of 4 to 5 feet and, providing the area has good drainage, is considered to provide a good footing for foundations.

The depth to which the permafrost reaches in the area is not known, but the depth of the active layer varies from 1½ to 3 feet, depending on the surface material, vegetation cover, and exposure.

The plain is covered by muskeg with scrubby alder and stunted black spruce and willows, the vegetation being thicker on the sides of the valleys. Willows predominate on the low, poorly drained and frequently flooded alluvial flats. Terraces which rise to about 15 feet above low water-level and are subject to only occasional spring flooding are better drained, and support spruce, much of which can be used as lumber.

Climate

The climate of Fort McPherson is warmer than would be expected considering its latitudinal position north of the Arctic circle, an anomaly attributed to the warming effects of the Mackenzie River and its tributaries. Long, cold winters and low precipitation are the main characteristics (Table 1). The average of 73 frost-free days, a year with only 9 frost-free days recorded, and an average minimum for January of − 21°, illustrate the length and the severity of winter. The average temperatures of three summer months are 53°, 58°, 53°F; the three winter months average − 21°, − 15°, − 7°F. Although the summers are cool, the temperature may reach the eighties. Annual precipitation is low (10.06 inches); but the annual rainfall of 5.2 inches does not include the frequent dew, and the moisture derived from thawing of permafrost, two sources of moisture that benefit the vegetation.

Break-up and Freeze-up

The break-up and freeze-up of the rivers regulate much of the life in Fort McPherson, because travelling and fishing activities have to be planned accordingly. Transportation is interrupted for 6 to 8 weeks during these seasons. The earliest break-up since 1945 occurred on May 13, and the latest on May 28; the earliest freeze-up occurred on September 28, the latest on October 21. The time of break-up is also the time of flooding when the water rises very rapidly and covers an extensive area of the flood plains. At Fort McPherson the water-level of the river usually rises from 15 to 20 feet above its low summer level; during the spring of 1957 it rose 32 feet. The flooding is caused by torrents of meltwater from the mountains and because break-up on the Mackenzie River occurs a few days later than that on Peel and Arctic Red rivers, with the result that ice jams form on Mackenzie River. The more severe the winter, and the thinner the snow cover, the thicker the river ice becomes and more severe flooding is likely to result. As the windswept Mackenzie freezes thicker than Peel River, this is also an important factor in the difference of time of break-up, formation of ice jams and resulting floods.

Settlement

The settlement is situated on the northern part of the hill previously described (Figure 2). The pattern of the street of the settlement is determined by the northerly trend of the bank of the Peel River. Location of

TABLE I

Climatic data of Fort McPherson

	Number years observed	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average Monthly Max. Temp. °F.	30	−13	−6	4	22	44	64	68	63	46	25	0	−8	26
Average Monthly Min. Temp. °F.	30	−30	−23	−18	−1	24	42	49	43	32	13	−13	−23	8
Average Monthly Mean Temp. °F.	30	−21	−15	−7	10	34	53	58	53	39	19	−7	−16	17
Average Monthly Rainfall (in.)	30					0.23	1.02	1.25	1.63	0.97	0.08	0.00	0.02	5.2
Average Monthly Snowfall (in.)	30	6.0	4.7	3.9	6.2	2.7	1.2	0.0	.7	3.1	8.0	6.8	6.0	48.6
		Average Annual Snowfall 48.6												
Average Monthly Precipitation (in).	30	0.60	0.47	0.39	0.62	0.50	1.14	1.25	1.63	1.28	0.88	0.60	0.62	10.06
		Average Annual Total Precipitation 10.6												

		Frost Date: Last Frost Spring			Frost Date: First Frost Fall			Frost Free Season Longest			Extremes on Record Shortest		
Average Frost Free Period—73	34	Average	Earliest	Latest	Average	Earliest	Latest	Last	First	No. days	Last Spring	First Fall	No. days
		June 10	May 23	July 14	Aug. 22	July 18	Sept. 10	May 29	Sept. 10	104	July 9	July 18	9

most of the natives' houses is haphazard. In 1950 the settlement was surveyed and a plan of its development prepared; building lots are available and new houses and roads built according to this plan. Figure 3 shows the position, type and function of the buildings in 1958. It is evident that little space for development is available for the natives because the building area is restricted by flood plains and because large tracts of land belong to government institutions, to the Hudson's Bay Company and the missions. In the near future the settlement will have to expand towards the southern part of the hill which is separated from the area of the present settlement by a swampy valley over which it will be necessary to build a road.

Public buildings comprise the Anglican and Roman Catholic churches, the community hall, a nursing station, a school and school hostel (Figure 4). Two power stations supply electricity to the government buildings, and will, in future, supply other buildings on a rental basis. A Canadian Pacific Airways office is housed with the Post Office.

The only administrative buildings are the game warden's office, housed with the Post Office, and the RCMP office. During the summer a tent is used for the detention of prisoners in the compound of the RCMP barracks.

Commercial establishments are represented by the Hudson's Bay Company trading post and the trading post of M. Krutko. Signs of awakening native enterprise are illustrated by the two cafés opened since 1956. Another private enterprise is the operation of tractor transport of supplies to and from boats and aircraft that arrive at the settlement.

The private dwellings of government and Hudson's Bay Company employees are modern bungalows which, due to the difficulties of building on permafrost, have no basements. The only exception is the house of the RCMP officer, and this house shows no sign of the destructive influence of permafrost. Five dwellings, provided for the Indians by the Indian Affairs Branch, Department of Citizenship and Immigration, are also of frame structure. The school, the teacher's house (Figure 4) and the hostel are modern two-storey buildings. All building materials for these structures were brought in barges down the Mackenzie River.

The school hostel, for 100 children, provides accommodation for the children of the trappers who spend a large part of the year in the trapping areas and thus are unable to send their children to school daily in McPherson.

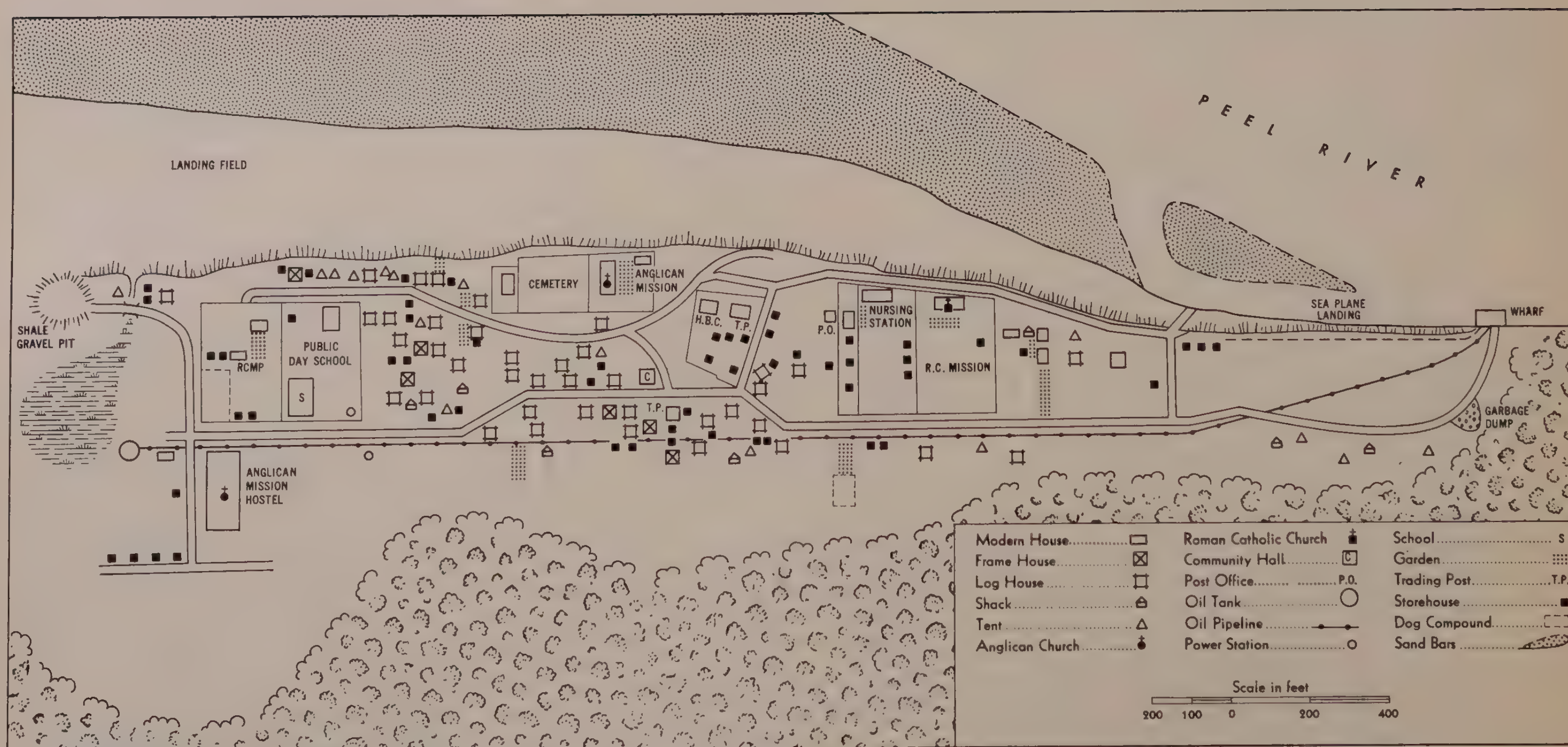

Figure 3. Settlement plan, Fort McPherson, 1958.

Figure 4

General view of Fort McPherson showing recent construction; including the new school hostel (right) the schoolteacher's residence (foreground) and RCMP office and dog compound (left centre).

Figure 5

A typical log house.

Figure 6

Semi-permanent tents and other dwellings.

The natives live in one-storey log houses (Figure 5). Spruce is the main building material, and roofing paper is used for roofs. The house is usually divided into two or three rooms, depending on the needs of the family. In spite of the rigors of the climate, many houses have no ceilings and are primitive in their furnishings. The five houses provided by the Indian Affairs Branch were built by carpenters brought from outside the settlement for lack of local skilled labor. Experience has shown that in some cases these houses were inadequate in size and presented problems of sanitation. The Indian Affairs Branch is preparing to build ten additional log houses with revised plans, employing local labor. A number of natives live in shacks built of miscellaneous materials while a few families spend the winter in semi-permanent tents with walls constructed of wood and roofed with double-wall tent material (Figure 6). Several types of storage houses built of logs have been developed to suit the climate, local conditions and occupations of the inhabitants. Dry fish, meat and flour are usually stored on the rafters in the attic of the stores. Many inhabitants build ice houses to ensure fresh water supply in summer. As Peel River is very muddy, the only source of fresh water supply is ice and snow. During the summer many of the inhabitants erect tents next to their houses where part of the family seeks shelter in warm weather.

Dog compounds are typical of this northern settlement as toboggans are still the main means of travel in winter using four or six dogs to a team. During the summer the dogs are tied near the dwellings. There are dog compounds in the settlement (Figures 3, 4) but as modern tracked vehicles, capable of travelling on snow and ice and crossing rivers, are available in a variety of types, the use of dog teams is declining.

In the gardens shown on the map (Figure 3) many vegetables are grown successfully, the most common being potatoes, cabbage, lettuce and tomatoes. The short growing season and low precipitation are compensated by long hours of daylight and moisture supplied by surface meltwater.

The roads in the settlement are surfaced with shale, quarried by a mechanical shovel in the nearby quarry and lack of gravel and sand near the settlement is a serious handicap. Gravel brought by barges from near Separation Point, cost $30 a ton in 1958. Rapid silting of Peel River near the settlement is another problem. In 1947 the boats used to moor in front of the HBC trading post, but this area is now a flood terrace, and the wharf had to be built 2,000 feet farther downstream for boats and float planes. As the level of the river may change rapidly 6 feet or more during

the summer, exposing or flooding large parts of the bank, the mooring of the planes must be closely supervised. The trader's small plane lands in the summer on the alluvial plain in front of the settlement.

Distribution of Cabins

Hunting, fishing and trapping are still the main occupations of the people and provide their main source of income. To obtain food and furs they migrate seasonally to the hunting and fishing areas. The trappers move with their families to their cabins in the middle of September with the result that Fort McPherson becomes partly depopulated. They remain until Christmas when they return to sell furs, buy new supplies and to take part in Christmas and New Year religious and social festivities. After New Year, the trappers return to their cabins, or make trips of several week's duration to the Richardson Mountains to hunt caribou and to trap furs. After June 15th the cabins are deserted and Fort McPherson becomes once more a busy place, At the end of July the natives again leave the settlement for their fishing camps, built on the river banks near good fishing grounds.

Most of the cabins belonging to the trappers of Fort McPherson are concentrated in the southern part of the Mackenzie delta and along Peel River to the Yukon Territory boundary (Figure 1). Apart from the Indian village there are only a few places in the delta where two or three cabins are clustered. The southernmost cabin belonging to McPherson natives was formerly located at Caribou River, but with the decline in the value

Figure 7 Trappers' cabin with sod-covered roof.

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of furs this, like many others, was abandoned, and the southernmost cabin in use today is located 58 miles from the settlement near the mouth of Trail River.

The trappers' cabins are usually of substantial log construction often with sod-covered roofs (Figure 7). Storage houses are sturdily built to prevent raiding by animals. The general storage house for trapping equipment and miscellaneous household effects is built on the ground, but the storage rooms for fur, dry fish and meat are built on poles 8 to 10 feet high. The poles are de-barked and downward-sloping tin collars are attached to make climbing difficult. On the trail, food and pelts are cached on platforms built on posts.

At the fishing camps most of the natives occupy tents or small log cabins. Wooden racks are built to dry fish, and smoke houses constructed of willow branches, covered with spruce bark, and tied with willow bark, are used for curing fish (Figure 8). A small fire smoulders in the middle of the smoke house.

Figure 8

Vittrekva, a Loucheux Indian guide, in front of his smoke house, built of spruce bark and willow branches.

Population

According to the records of the Anglican parish the total population of Fort McPherson in 1958 numbered 453 persons. Of this, 23 were white, 25 white status Indians, one Eskimo, and the remainder Loucheux Indians. The Indians belong to the Kutchin tribe. The early French Canadian voyageurs called the tribes who lived on Peel and Porcupine rivers, "Loucheux", meaning "squint eyed" (Jenness 1958). For administration purposes the Indians are divided into bands. The Indians of Fort McPherson belong to the Loucheux Band No. 7. Their nearest neighbours, the Indians

of Arctic Red River, belong to the Loucheux Band No. 6. Each band elects its chief and three counsellors for a period of 2 years. The Loucheux language belongs to the Athabaskan family of languages; it has been transcribed, but the printed word is restricted mainly to religious books. Owing to the reluctance of the young people to speak Loucheux, however, the language is rapidly disappearing.

The analysis of the population of Fort McPherson is based on the records of the Anglican parish, from data of the Indian Affairs Branch, and from publications of the Dominion Bureau of Statistics. The records of births, deaths and marriages have been kept by the Anglican ministers since 1895, although data from 1918 to 1926 are missing. The data available from the Indian Affairs Branch are from 1946 (Census of Indians 1952 and 1955).

One of the most striking changes in population is the change in racial composition of the Fort McPherson area from the 19th to the 20th century. The population in 1871 was composed of 351 Loucheux Indians and 350 Eskimos, whereas in 1958 only 1 Eskimo lived in Fort McPherson, having moved there the previous year. It appears that the Eskimo did not tend to settle permanently in the area but visited it to trade, sometimes remaining for prolonged periods. With the decline in the number of fur animals and the reduced price for pelts the advantages of trading with Fort McPherson were not strong enough to attract the Eskimo to settle. They gradually withdrew farther north into the delta and the open tundra of the coast which they prefer to wooded areas. The general decline in the Eskimo population at the turn of the century must also have been an important factor in their withdrawal from the area.

The records of the parish show several instances when an epidemic of influenza swept away a large part of the population. The worst was in 1901–1902 when 47 people died. In 1928 and 1929 another epidemic carried off 43 people. Table 2 shows a decline in population from 321 in 1946 to 307 in 1949, caused by an epidemic in 1948. From 1949 to 1955 the population increased steadily to 383, and continued to increase to 408 in 1958. The total number of females is greater than males, as in Canada as a whole. Further, the proportion of females to males is tending to increase. In 1946 there were 11.3 more females per 100 males, and in 1958 this proportion increased to 12.4 per 100 males.

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Table 2

*Indian Male and Female Population, by Age Group, Fort McPherson, 1946 and 1958**

Age group	1946		1949		1952		1955		1958	
	M	F	M	F	M	F	M	F	M	F
0– 6 Years......	35	40	32	39	27	35	30	45	28	54
7–11 "	20	36	23	31	32	43	30	45	28	39
12–19 "	22	25	24	31	24	40	32	44	41	55
20–49 "	42	46	40	45	52	48	61	46	62	52
50–69 "	25	16	24	12	20	14	20	20	17	20
70 "	7	7	3	3	2	6	5	5	6	6
Totals, all ages....	151	170	146	161	157	186	178	205	182	226
Total............	321		307		343		383		408	

*Source: Indian Affairs Branch.

A comparison of the vital statistics of the Indian population of Fort McPherson with Canada as a whole indicates that the average birth rate, natural increase, and infant mortality for the years 1946 to 1955 were all much higher in Fort McPherson.

Table 3

Fort McPherson—Vital statistics per 100 population, 1946-1955

Year	Birth rate	Death rate	Natural increase	Infant mortality*
1946 Ft. McPherson...........	7.80	2.80	5.00	16.00
Canada.................	2.70	0.94	1.76	4.7
1949 Ft. McPherson...........	5.50	0.65	4.95	5.8
Canada.................	2.73	0.92	1.81	4.3
1952 Ft. McPherson...........	4.38	1.46	2.92	13.3
Canada.................	2.79	0.87	1.92	3.8
1955 Ft. McPherson...........	3.38	0.00	3.38	0.0
Canada.................	2.82	0.82	2.00	—

* Per 100 live births.

Source: Indian Affairs Branch, and Dominion Bureau of Statistics.

The high natural increase is mainly due to this high birth rate (Table 3). The death rate, which was much higher for Fort McPherson than for Canada in 1946, shows a decline below the 1955 Canadian average. However, with

a small population such as this, the rates change from year to year. The high natural increase can also be illustrated by the fact that from December 1950 to June 1958, 17 deaths occurred, including 5 still births. For the same period of time, 139 births were recorded.

Food

The main food of the natives is fish, mostly whitefish and inconnu, caught mainly in the late summer and early fall before freeze-up. The usual method of fishing is with gill nets. In winter, fishing through the ice by means of nets and jigger is done only to obtain supplementary supplies of fresh fish. The fish is cleaned, sliced and halved, then partially dried in the open air. After a day or so it is hung in a smoke shack where it undergoes final drying. The number of fish stored depend on the size of the family and the number of dogs; 2,000 fish for the winter is considered a good supply for a family of five, and six dogs. Caribou and moose meat are valued highly; five carcases provide a sufficient supply of meat for an average family in the winter months, but the hunter cannot depend on obtaining this game. It is customary that the caribou and moose brought from the hunt be shared by the community. Meat of the muskrat is also consumed, both fresh and dried, although the dried meat is used mainly for dogs. Bear meat is never eaten from choice; it is usually given to the dogs. Ducks, geese and ptarmigan are shot in small numbers only. The growing of vegetables is uncommon among the native trappers, but vegetables are grown in small gardens by the white residents. Wild berries growing in the area are also preserved by an increasing number of natives.

Income

It is difficult to estimate the average income of the natives. The total revenue of Fort McPherson for 1958 was estimated at $318,000, but this included the salaries of government employees (about $45,000) and wages of the construction workers in charge of the construction of the new school hostel. The average annual per capita income of the natives in 1958, estimated by the superintendent of the Indian Agency at Aklavik, is as follows: wage employment $130, trapping $90, family allowance $42, treaty money $5.00, (total $272.00). This figure illustrates that the native economy is largely self-sufficient. Temporary employment was provided in the settlement during the construction of the hostel and school. A few men from Fort McPherson obtain seasonal employment of varying duration in Inuvik.

The sawmill near the Indian village cut about 100,000 feet of lumber in 1958, and is the family enterprise of a white resident who sells his products mainly to Aklavik and Inuvik, very little being bought by the inhabitants of Fort McPherson. The natives cut their own logs for buildings and fire-wood.

As a result of a shortage of cash, barter is used in much of the exchange of goods and services. Similarly, church offerings are frequently made in furs. This is especially so on "Muskrat Sunday" which is a form of Thanksgiving Sunday, celebrated in spring after the end of the trapping season.

The transition from the self-sufficient economy of the trappers and hunters to modern economy is difficult. The traditional occupations do not bring sufficient returns, and those who have a chance to try a different way of life are reluctant to return to trapping. In the meantime, the natives are becoming more and more dependent on government support. One of the obstacles to raising the economic standard of the natives, and providing gainful employment for them is their work attitude, as many will remain in employment only until they have earned enough to buy a desired object. Although fish are plentiful in the area, the manager of the school hostel finds that the natives cannot be relied upon to supply fish on a regular basis.

Travel and Communication

In winter, on hunting and trapping trips, the natives use dog teams. The hunting of caribou involves long journeys to the Richardson Mountains, and the winter trails follow the Peel River and of its tributaries, Rat River, Stony Creek, Vittrekwa, Trail and Caribou rivers. Women travel with the party to set up and look after the camp. These hunting trips may cover several hundred miles and last for several weeks.

Another frequently used trail is between Fort McPherson and Arctic Red River, mainly for the exchange of meat and fish between the two settlements. The trails are marked by blazes and broken branches. The scrubby forest, muskeg, and swarms of mosquitoes present many difficulties to travelling during the summer; during this season the natives travel to and from their hunting and fishing areas by canoe. A few natives have small scows used to transport their families, the dogs, and heavy supplies, at the beginning and end of the trapping season.

Winter travel conditions are often difficult near Fort McPherson because the river and lake ice tends to be rough as a result of thawing and re-freezing. The accumulation of snow prevents the formation of thick ice, and this is a further hazard.

Most bulk goods reach the settlement by river. Depending on the amount of cargo, 2 to 4 boats of the Northern Transportation Company and the Yellowknife Transportation Company call during the summer.

Canadian Pacific Airways maintains a weekly service to Fort McPherson and Aklavik, except during the break-up and freeze-up periods. The Hudson's Bay Company maintains regular radio contact with other settlements.

The intensive mineral exploration of the area, and the surveying of the proposed road from Dawson to Fort McPherson are beginning to show their impact on the settlement and bring the hope that with the opening up of the area the economic standard of the natives may be raised and integrated with the rest of Canada.

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A NOTE ON A PERIGLACIAL EROSIONAL PROCESS IN THE ISACHSEN AREA, N.W.T.

*Claude Lamothe and Denis St-Onge**

ABSTRACT: In several regions of the Canadian Arctic, the melting of ground-ice triggers erosional processes that bring about the removal of large quantities of unconsolidated material on steep valley walls. As a result, large hollows are rapidly excavated by mud flows. Measurements made on Ellef Ringnes Island show that the back wall of such a hollow retreated by as much as 10 m in one season. These processes are considered to be among the most rapid erosional agents now active under the present periglacial morpho-climatic conditions of the High Arctic.

During the 1960 field season the writer studied periglacial processes on Ellef Ringnes Island, N.W.T., and observed an unusual form of periglacial erosion at a location 5 kilometres northwest of Isachsen. This erosional process involved ground-ice and mudflows, phenomena which, although probably widespread, have rarely been studied in detail. They are, however, of considerable importance as they are among the most rapid erosional agents in certain parts of the Arctic.

On Ellef Ringnes Island ground-ice is generally hidden under a layer of silt or other unconsolidated material. When exposed, the ice begins to melt and produces mudflows that excavate hollows.

Although seldom reported in the literature these features have been observed in a few widely scattered areas on the Canadian Arctic islands, for example, an Axel Heiberg Island (Greffard)†, on the north shore of Lake Hazen (Brochu)†, and on Banks and Victoria islands (Washburn, 1947 p. 85–86). The scarcity of data on these forms in the literature probably explains why they are not included in recent summaries of periglacial features in Canada (Cook, 1959; Hamelin, 1960).

Morphological maps, such as the one made by Robitaille for the Mould Bay area (Robitaille, 1960) are invaluable in the documentation of these phenomena and could be a vital aid in the choice of northern construction sites, such as meteorological stations and landing strips. Furthermore,

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*Claude Lamothe, B.A. Montreal, 1958; Denis St-Onge, B.A. Manitoba, 1951, Lic. en Sci. Louvain, 1957. The paper is based on field work carried out as part of the Polar Continental Shelf Project. The Geographical Branch field party was led by D. St-Onge, assisted by C. Lamothe and H. Morrissette.

†Personal communication.

MS. submitted October, 1960

costly maintenance could be reduced. At Isachsen, for example, the landing strip has to be worked over each summer to make certain that the underlying ground-ice has not been disturbed.

GROUND-ICE

Before describing the feature in its several stages of evolution it is necessary to describe the various factors that come into play; the ground-ice and its silt cover.

The phenomenon observed was particularly active on the steep side of an asymmetric valley where ground-ice lay buried under the active layer composed of silt. The exact dimensions of the ground-ice mass in the area have not been established. However, several outcrops and drillings indicate that the lowlands around Isachsen (0 to 50 metres above sea-level) are underlain by a fairly continuous mass of ground-ice. Many more drillings, however, would have to be completed before this could be conclusively established. In the area studied, the thickness of the buried ice mass was ascertained by drilling with a hand auger, and the ice cores obtained varied in length from 0.37 to 0.55m. Variations in thickness are probably due to either sub-ice surface irregularities or to the melting of the ice surface by melt-water seepage (cryokarst).

The origin of ground-ice in arctic regions is still an unsolved, though well-studied problem. Several hypotheses have been suggested for similar features in other parts of the world, and these can be reduced to the two following alternatives: ice masses (sea or glacial ice) buried during the Pleistocene age; or ice formed at depth during the downcreep of permafrost (*see*, for instance, Dahl, 1885; Leffingwell, 1919; Seemann, 1853, Taber, 1943). The problem of the origin of ground-ice at Isachsen, however is beyond the scope of this paper. Whatever its origin, ground-ice is responsible for the formation of this particular periglacial feature.

THE ACTIVE LAYER

In the study area the active layer was essentially silt, with only sparse vegetation. The surface was covered with small polygons (0.05 m to 0.20 m in diameter), outlined by mud cracks formed by the drying of the silt. Mud cracks or desiccation cracks, and the resulting myriad of small polygons are not restricted to Arctic regions but are found on the surface of most recently dried silt or clay deposits in any latitude.

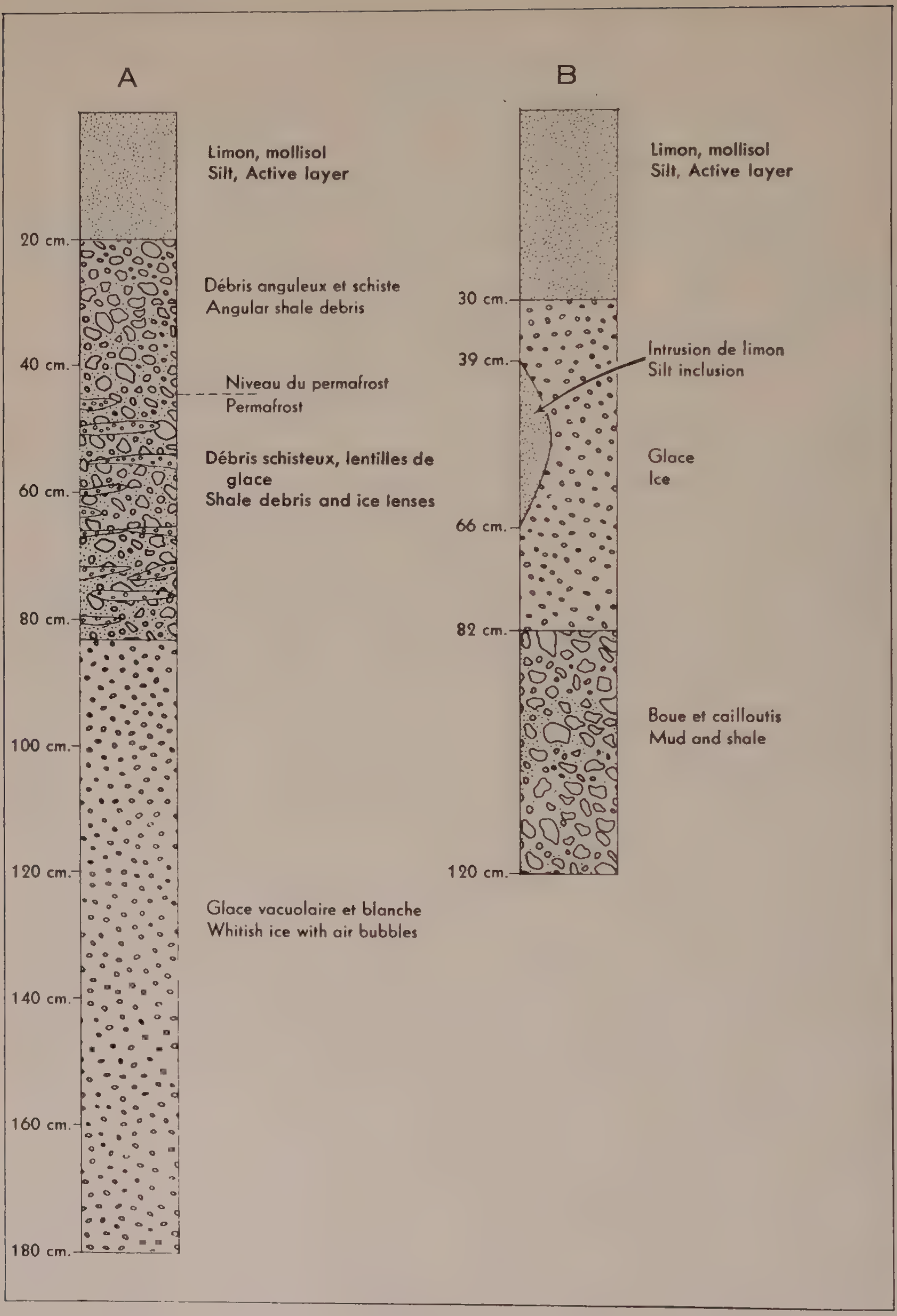


Figure 1.

A. Soil profile at Isachsen.

B. Soil profile in the area studied.

A. Coupe verticale dans le sol à Isachsen.

B. Coupe verticale dans le sol de la région étudiée.

Thickness of the silt on the valley floor was 0.30 m on the average (Figure 1B). The line of demarcation between silt and ground-ice was quite sharp. This, however, is not always the case, as a soil section from a hole dug at Isachsen showed a layer of angular shale debris between the ice and the surface silt (Figure 1B).

THE PROCESS

The various elements described above are triggered into activity under very specific circumstances. The first phase of the process takes place when the stream undercuts its steep left bank. In spite of its weak current (0.75—1.25 m/sec) and its low rate of discharge (3—10 m^3/sec) the river is still able to cut the base of the steep concave side of a large meander. This steep side is constantly and rapidly retreating. When the base of the steep valley side has been actively eroded, part of the wall crumbles (Figure 2A, 2B). This break in slope in turn triggers a mass movement which may affect the top of the slope. This type of mass movement is part gravity fall and part solifluction, and has been described by several authors (Washburn, 1947; Williams, 1957, 1959).

The process rapidly lays bare part of the ground-ice that lies near the top of the slope (Figure 2C), and temperatures near the surface that may reach 25°C (78°F) quickly melt the ice. It is doubtful that air plays a major role in the melting of ground-ice, as air temperatures average 2°C (35°F) for the warmest month, with maxima reaching 8°C (46°F). It would appear that insolation (Chang, 1958) is a critical factor as the melting of outcropping ground-ice is in direct proportion to its exposure to the sun.

The second phase of the process is the crumbling or slipping of silt blocks caused by the melting of the underlying layer of ground-ice. Repetition of this process eventually carves a semi-circular hollow that increases in size with the melting of the ground-ice layer. The hollow openings towards the river eventually become 1 to 2 metres deep, with a floor sloping between 1° and 2°. Once the hollow has been established, it collects silt and melt-water to form a thin mud, and the almost unlimited supply of moisture from melting ice keeps the mud extremely fluid.

From this stage on, the material is carried from the hollow firstly by mud flow, which carries the liquid mud, and secondly by solifluction, which removes the more viscous material. This material moves very slowly and forms a series of overlapping lobes (Figure 2D).

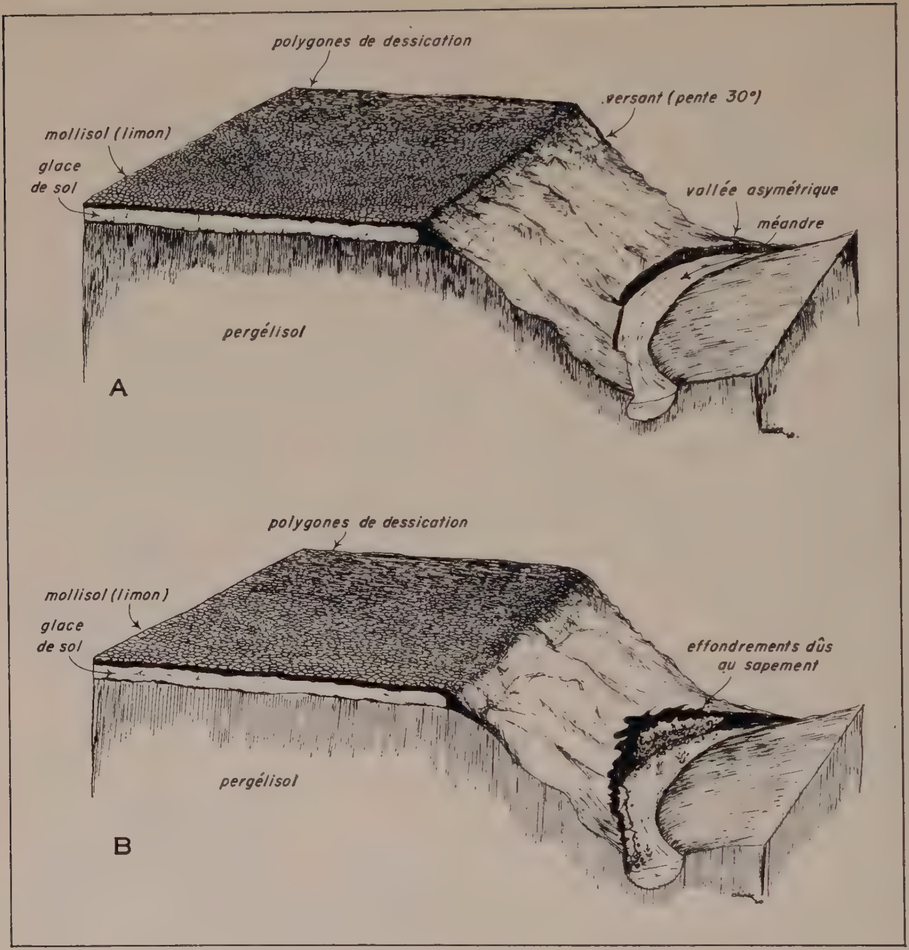


Figure 2. A. Valley walls prior to mudflows.
B. Slumping on steep slope due to sapping by a river meander.

A. Forme des versants avant le déclenchement des coulées de boue.
B. Effondrement d'un versant sapé par un méandre.

The liquid mud forms a stream (Figure 3) that flows continuously during the warm summer months and forms a mud-flow delta that partly clogs the river. The source of this stream is the back wall which is exposed to direct insolation (Figure 4). The more viscous material originating from the less exposed lateral walls of the hollow moves slowly and forms a series of parallel ridges and hollows. Upon reaching steeper slopes (20°) large masses of this material slip down to the river bed, leaving a series of striæ on the slip-plane (Figure 5).

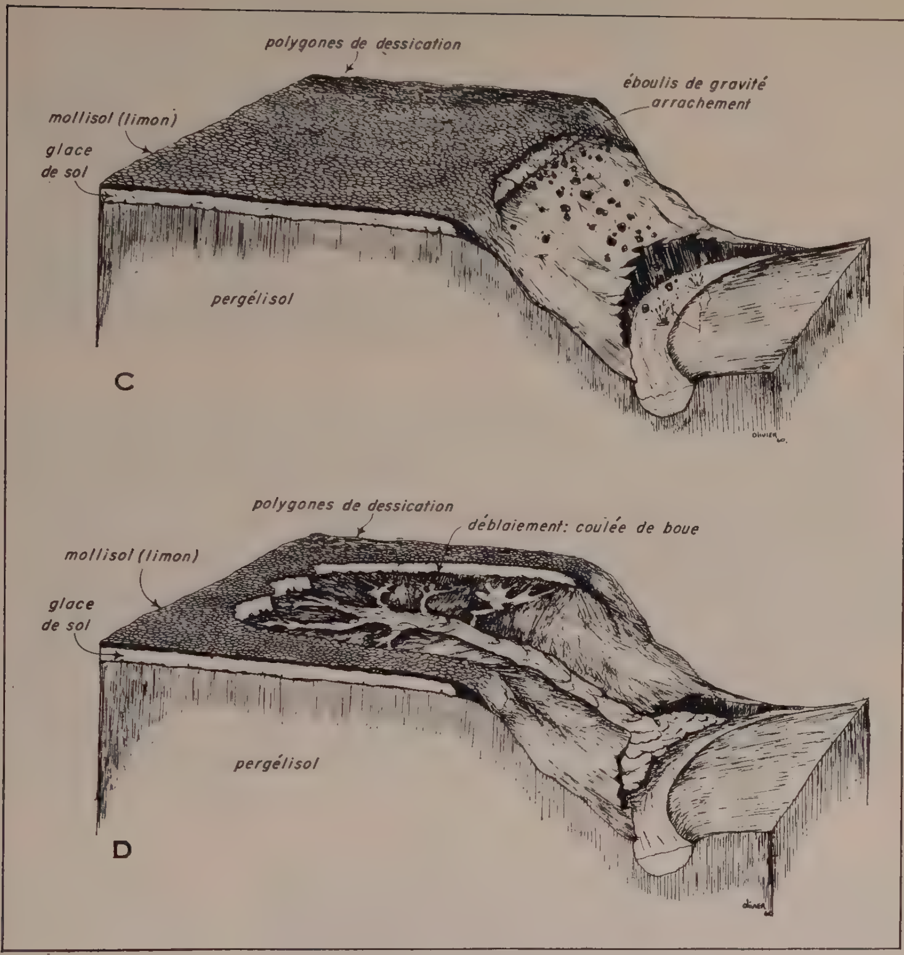


Figure 2. C. Gravity fall which exposes the ground ice.
D. Mudflow excavating a hollow.

C. Éboulis de gravité exposant la glace de sol.
D. Coulée de boue et excavation d'une niche.

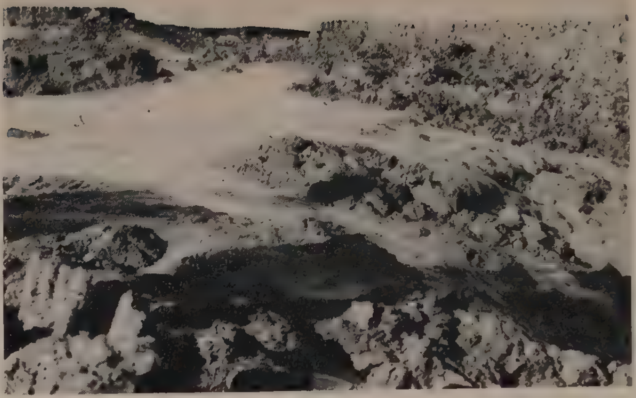
EVOLUTION OF THE HOLLOW

The processes described above are responsible for the very rapid erosion of a section of the river bank. Measurements showed that during the summer months of 1960 the back wall of the study area retreated an average of 7 metres, with a maximum retreat of 10 metres. Erosion is less on the side walls as they are less exposed to direct insolation. The northeast and west wall retreated 0.5 m and 2 m respectively. In the latter case,

Figure 3

Mudflow inside the hollow.

Coulée de boue à l'intérieur de la niche.



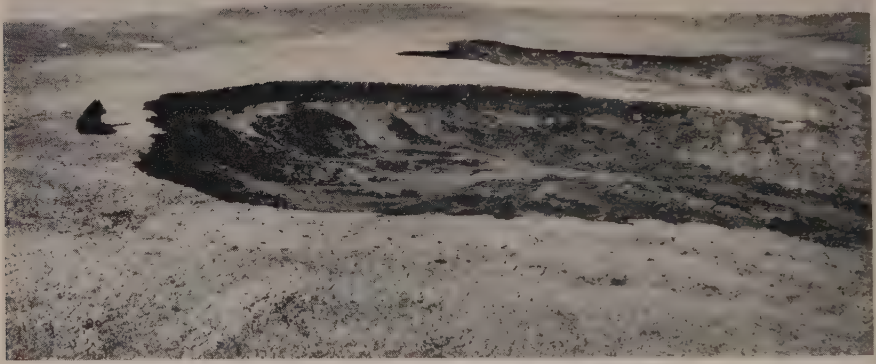


Figure 4. Shape of the hollow on August 15, 1959

Forme de la niche, le 15 août 1959.

Figure 5

Striae formed by the sliding of lumps of mud on the steep face of the valley wall.

Stries formées par le glissement de mottes de boue sur le versant raide.

the process is further slowed down because here a thinner layer of ground-ice is quickly insulated by sliding masses of silt which remain undiluted because of a lack of sufficient moisture supply (Figure 6). These observations led to the conclusion that insolation and ground-ice are essential factors in the formation of this type of periglacial feature. Another obvious conclusion is that the greater the insolation and the thicker the ice, the more rapid the process becomes.

The mud stream draining the hollow flows at an average rate of 5 to 10 m/sec. Although this might slow down considerably after a few cool, cloudy days, the measurements show that the process can be rapid. Quantitative data concerning the rate of movement of the less fluid mud are more difficult to obtain, however it is probably between 0.5 m and 1 m per season. During its period of activity, the process excavates a hollow up to 40 metres in diameter, and removes several thousand cubic metres of unconsolidated material.

The slowly retreating lateral walls, and the well-hollowed back wall show that the process is in its last stage. Eventually the ground-ice outcrop which generates the whole process will be reburied and the mud-flow will stop for lack of adequate moisture supply. In time, however, the laterally moving stream meander will re-start the whole process.

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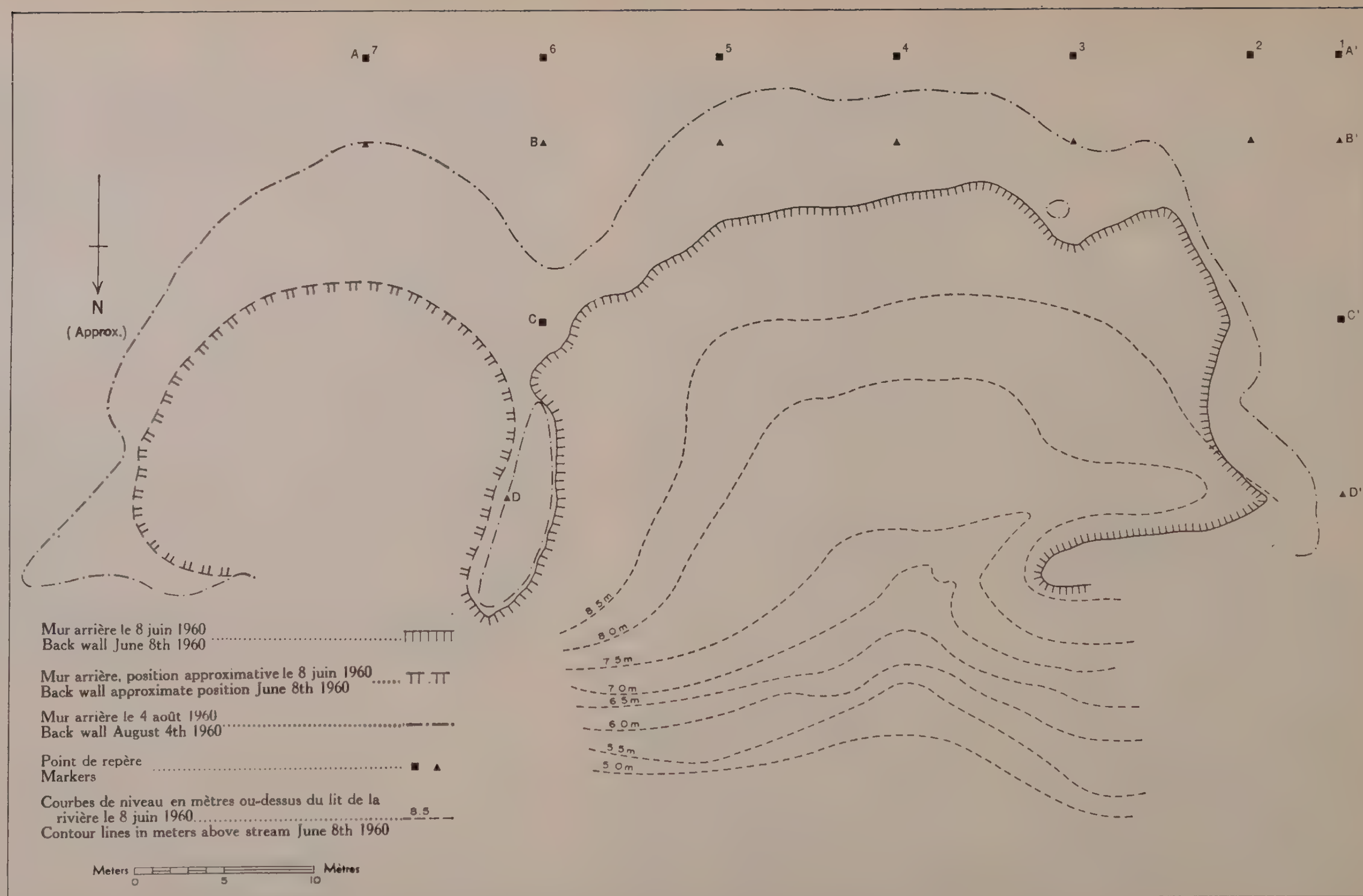

Figure 6. Map of the two hollows studied.

Cartes des deux niches étudiées.

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OBSERVATIONS D'UN PROCESSUS D'ÉROSION PÉRIGLACIAIRE DANS LA RÉGION D'ISACHSEN (T. N.-O.)

*Claude Lamothe et Denis St-Onge**

RÉSUMÉ: La fonte de la glace de sol est responsable du déclenchement de processus d'érosion très puissants à plusieurs endroits de l'Arctique canadien. Sur l'île Ellef Ringnes, les observations recueillies montrent que les murs d'une niche d'arrachement ont été reculés de 10 m, en même temps qu'une masse de plusieurs centaines de m^3 de mollisol se faisait emporter sous la forme d'une coulée de boue. Il semble que ces processus d'érosion soient parmi les agents érosifs les plus dynamiques (vitesse d'érosion) existant présentement en climat périglaciaire.

Au cours de la saison 1960, l'on a pu observer, à 5 km au nord-ouest d'Isachsen, sur l'île Ellef Ringnes, (T.N.-O.), un processus d'érosion périglaciaire aux caractéristiques bien particulières, dû à la fonte de la glace de sol. Le processus en question est un phénomène très actif dans plusieurs régions des Îles Reine-Élisabeth, mais il ne semble pas avoir attiré, jusqu'à maintenant, l'attention des chercheurs canadiens. Jusqu'ici les scientifiques de diverses disciplines se sont surtout attardés à l'analyse de la glace elle-même, c'est-à-dire à son origine (si fossile) ou à son mode de formation (si contemporaine), et à ses diverses propriétés physiques, chimiques, bactériologiques, sans s'arrêter sur son rôle dans l'élaboration de certains traits du paysage (à l'exception évidemment des pingos et des thermokarsts).

Il est à espérer que les processus d'érosion déclenchés par la fonte de la glace de sol seront désormais étudiés de plus près, car ils comptent parmi les agents érosifs les plus dynamiques (vitesse d'érosion) en climat périglaciaire.

Sur l'île Ellef Ringnes, la glace de sol repose enfouie sous une couverture de limon; mais une fois mise à jour, elle fond rapidement créant de fortes coulées de boue et éventrant le sol en trouées béantes. A certains endroits de l'île Axel Heiberg (C. Greffard)† de même que sur l'île Ellesmere, notamment sur la rive nord du Lac Hazen et sur les rives de la rivière Salor (M. Brochu)†, et aussi sur les îles Banks et Victoria (Washburn, 1947, p. 85–86), la fonte de la glace de sol est responsable de phénomènes périglaciaires similaires (les processus et les formes résultantes).

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* Claude Lamothe, B.A., Montréal, 1958; Denis St-Onge, B.A., Manitoba, 1951, Lic. en Sci. Louvain 1957. Les problèmes discutés dans cet article furent étudiés sur le terrain alors que les auteurs participaient à l'Étude de la plate-forme continentale polaire. L'équipe de la Direction de la géographie était sous la direction de Denis St-Onge, assisté de C. Lamothe et de H. Morrissette.

† Communication personnelle.

A l'échelle de l'Arctique canadien, ces quelques cas isolés et nouvellement relevés tiennent encore une place insignifiante parmi les nombreux autres phénomènes périglaciaires identifiés jusqu'à présent. C'est sans doute pourquoi Cook (1959) et Hamelin (1960) dans leur essai de synthèse du fait périglaciaire au Canada omettent de parler de la fonte de la glace de sol, et de son action morphogénique.

L'élaboration de cartes morphologiques, comme celle de B. Robitaille pour la région de la baie Mould (île Prince Patrick, T. N.-O.) (Robitaille 1960) constituerait sans aucun doute une excellente source d'information sur les phénomènes de cette nature, ou du moins aiderait à prévenir des erreurs dans la localisation des sites et des pistes d'atterrissage, dans les régions arctiques. Des soins coûteux d'entretien, comme c'est le cas à Isachsen, où des béliers mécaniques doivent veiller à ce que la masse de glace, sur laquelle est construite la piste d'atterrissage, ne soit pas dépouillée de sa couverture protectrice, seraient aussi évités.

La glace de sol

Avant de décrire le processus dans ses différents stades d'évolution, il serait bon d'avoir un aperçu du contexte dans lequel se déroulent les forces en jeu, c'est-à-dire une notion de ses éléments constituants: la glace de sol, et sa couverture de limon.

Le phénomène observé sur l'île Ellef Ringnes fut particulièrement étudié sur le haut du versant raide d'une vallée dissymétrique, où une masse de glace de sol repose enfouie sous une couverture de mollisol formée de limon. Les dimensions exactes de la masse de glace restent encore à déterminer. Les sondages effectués à onze endroits sur une longueur et une largeur de plus de 100 m permettent, toutefois, d'affirmer que l'étendue de la masse en question dépasse celle d'une simple lentille, et qu'elle s'allonge sur une superficie assez considérable, puisque, à 3 km au sud, la piste d'atterrissage est aussi localisée sur une masse de glace de sol, de même que la station météorologique d'Isachsen, à 5 km au sud-ouest. Cependant, il serait prématuré de prétendre que la glace relevée à ces trois endroits différents, fasse partie d'une même masse se prolongeant sur plus de 5 km. Les différences topographiques sont trop énormes pour que l'hypothèse soit acceptée sans plus de preuves.

Le problème concernant l'épaisseur de la masse enfouie a pu être résolu d'une façon plus concluante (figure 2). Les échantillons prélevés à l'aide d'une foreuse à main ne laissent pas de doute sur les limites de sa profondeur:

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les valeurs s'échelonnent entre 0,37 et 0,55 m. Les irrégularités de la couche sont vraisemblablement dues à la topographie capricieuse du substratum, sur lequel repose cette glace, de même qu'à l'érosion de cette glace par les eaux de surface à certains endroits.

L'énigme de l'origine de cette glace de sol n'a pu être déchiffrée d'une façon satisfaisante en raison de la limitation des moyens techniques disponibles. Sans doute que des expériences ultérieures permettront d'établir le processus de sa formation. De nombreuses hypothèses ont été émises sur l'origine de la glace de sol observée ailleurs dans le monde. En général, les hypothèses se ramènent à l'alternative suivante, à savoir si l'on est en présence d'une masse fossile enfouie au Quaternaire ou d'une masse de formation contemporaine: Dall (1881), Leffingwell (1919), Seemann (1953), Taber (1943). Cette solution ne présente toutefois aucun intérêt immédiat, puisque, quelque soit son origine, la glace reste responsable du déclenchement d'un processus d'érosion, et c'est la description de ce processus qui nous intéresse ici.

Le mollisol

Le processus prend place dans une couverture de matériel non consolidé et sujet aux actions du gel-dégel. Ce mollisol constitué essentiellement de limon ne supporte qu'une végétation très clairsemée; mais il est aussi disséqué en une infinité de polygones 0,05 m à 0,20 m de diamètre, formés par le dessèchement du limon qui, imbibé d'eau, a subi un gonflement, puis une contraction pour devenir fissuré de craquelures de retrait (figure 1) (mud-cracks des auteurs anglais). Phénomène, d'ailleurs, qu'on retrouve souvent sur le fond d'anciens lacs desséchés, ici même dans le Sud du Canada.

L'épaisseur de la couverture de mollisol a pu être établi à 0,30 m; évaluation assez facile à déterminer, puisqu'ici la démarcation entre le limon et la glace de sol est très nette (coupe 1) contrairement à ce qu'on a pu observer à Isachsen même où le limon est séparé de la couche de glace par un horizon de débris de schistes et de fines lentilles de glace (coupe 2).

Le processus

Cette brève description des éléments en cause nous amène maintenant à parler du processus lui-même.

La première phase du processus (diagramme 2) s'amorce avec les attaques répétées d'une rivière à régime nivo-pluvial coulant sur le fond d'une vallée dissymétrique; malgré un potentiel érosif limité, dû à la faiblesse du courant (entre 0,75 et 1,25 m/sec) et de son débit réduit (entre 3 et

10 m^3/sec), le cours d'eau réussit à saper le versant de la rive concave d'un méandre. Dans ces conditions, le recul de l'abrupt se fait rapidement, même si l'état de gel permanent du matériel meuble renforce sa résistance à l'érosion. Sapés à leur base, des bancs de pergélisol s'effondrent, causant une rupture de la pente dont l'inclinaison normale se situe autour de 30°. Le point d'équilibre étant rompu, des éboulis de gravité se déclenchent là où le versant est devenu trop raide, venant ainsi ajouter à la force de l'érosion due à la solifluxion et décrite par plusieurs auteurs dont Washburn (1947), Williams (1957) (1959).

Cette évolution graduelle de la pente provoque l'arrachement de la couverture protectrice de la glace, et celle-ci, une fois mise à jour, fond rapidement sous les effets de température de surface qui peuvent atteindre 25°C (78°F). Il est douteux que l'influence de l'air ambiant dans la fonte de la glace soit considérable, puisque les moyennes de température du mois le plus chaud gravitent autour de 2°C (35°F), avec des maximums dépassant rarement 8°C (46°F). Il apparaît donc que l'insolation (Chang, 1959), joue un rôle de premier plan: la glace fond proportionnellement à son exposition aux rayons solaires, l'ablation se faisant à partir des parois découvertes.

La deuxième phase du processus (diagramme 3) débute à partir du moment où des bancs de mollisol, privés de leur base de glace, qui fond, s'effrondent dans le vide laissé par le recul des parois, ou encore lorsque se produit, à la surface de ces mêmes parois, un glissement dû à un plan de faiblesse le long d'une fente de dessiccation.

La répétition de ces arrachements ou encore de ces glissements de bancs de mollisol finit par sculpter une niche semi-circulaire qui s'agrandit en même temps que le retrait de la glace. Il en résulte une cavité dans le sol de 1 à 2 m de profondeur, pouvant s'étendre sur plusieurs dizaines de mètres, et dont le fond épouse partout la pente du replat selon une inclinaison ne dépassant jamais 2°.

Du moment que la niche prend forme, elle devient un réceptacle où s'accumulent le matériel éboulé et l'eau de fonte de la glace. Dans ces conditions, la dilution du limon en une boue visqueuse, puis liquide, peut se faire sans difficuté, puisque l'alimentation en eau est continuelle, et non sujette aux fluctuations de quelques rares et maigres précipitations ou encore au ruissellement printanier de l'eau de fonte.

La troisième phase du processus (diagramme 4) s'identifie avec les phénomènes de solifluxion prenant place à la surface du pergélisol sur le

fond de la niche. Les processus en action, dans cette dernière phase, concourent tous à déblayer la cavité, du matériel arraché aux parois. Une grande partie du limon s'écoule sous la forme d'une boue liquide qui est transporté hors de la niche à partir de plusieurs ruisselets secondaires se déversant dans un collecteur principal (figure 3). Une autre proportion du matériel se dégage sous forme d'une lente coulée de boue avançant par chevauchement de bourrelets.

Dans le premier cas, la boue est fluide, parce qu'elle est en contact immédiat avec la paroi la plus directement exposée à l'insolation; dans l'autre exemple, le limon se dilue plus difficilement en raison de la moindre intensité de l'insolation, le long des parois latérales opposées à l'exposition des rayons solaires. Au lieu de s'écouler, la masse boueuse s'évacue alors par glissements et par soubresauts, visibles aux bourrelets transversaux qui la serpentent et aux stries témoins sur le pergélisol (figure 4). Aux sorties de la niche, toutefois, l'avancée cesse d'être spasmodique pour devenir continue, obéissant ainsi à l'augmentation de la pente, qui passe de 2° à 20°.

Évolution de la niche

Tous ces processus d'érosion sont responsables, dans leurs diverses phases, d'une action érosive accélérée (figures 5 et 6). Les mesures recueillies, au cours de 12 semaines, démontrent un recul des parois arrière sur une profondeur moyenne de 7 m, la régression atteignant jusqu'à 10 m le long de certains plans de faiblesse. Les valeurs sont évidemment moins fortes sur les parois latérales, en raison de leur orientation opposée ou oblique aux rayons solaires; la retraite de la glace sur la face nord-est, par exemple, ne dépasse pas 0,50 m, alors qu'elle accuse des gains d'à peine 2 m sur la face ouest. Dans ce dernier cas, toutefois, le ralentissement de la régression s'explique par la plus faible épaisseur de la glace et par l'écroulement précipité des bancs de mollisol qui s'accumulent les uns sur les autres, avant de pouvoir être dilués par la trop faible quantité d'eau de fonte, suscitant ainsi un réenfouissement de la glace. Cela nous amène donc à dire que l'insolation s'avère indispensable à la progression du processus et à l'évolution de la niche: les températures de surface les plus élevées commandent les éboulis de mollisol les plus considérables.

Quant à la coulée de boue, à l'intérieur de la niche, les mesures recueillies révèlent que la partie fluide, lorsqu'elle est en mouvement, s'écoule à une vitesse moyenne de 5 à 10 cm/sec. Les ordres de grandeur pour la

partie solide s'évaluent plus difficilement, en raison de l'avance désordonnée de la masse boueuse. Cependant, les observations disponibles font présumer des gains de 0,5 m à 1 m par saison.

L'état actuel de la niche, avec ses murs latéraux qui ne retraitent plus ou presque, et sa paroi arrière qui est en régression diminuée, démontre clairement que le cycle d'érosion est maintenant dans ses dernières phases, et que l'évolution est sur le point de prendre fin (pour la niche observée).

Tout de même, durant leur courte période d'activité, les processus engendrés par la présence de la glace de sol auront été responsables du creusement d'un cratère de 40 m de diamètre et de l'arrachement de plusieurs milliers de mètres cubes de matériel meuble.

Remerciements

Les auteurs désirent remercier M. Hugues Morrissette pour sa précieuse collaboration sur le terrain, de même que M. J. Claude Olivier dont le talent a permis la réalisation des blocs-diagrammes présentés dans cet ouvrage.

A NOTE ON HIGH-LEVEL MARINE SHELLS ON FOSHEIM PENINSULA, ELLESMERE ISLAND, N.W.T.

Victor W. Sim

Between August 20 and 23, 1955, the writer and Dr. David F. Parmelee* visited the area of Fosheim Peninsula south of Slidre Fiord on the west coast of Ellesmere Island, N.W.T., and made a number of foot traverses to areas of interest in the vicinity of Hare Cape Ridge. On two of these traverses fragments and unbroken shells of marine mollusks were found at elevations considerably above the reported maximum heights for similar shell occurrences elsewhere in the Arctic and, indeed, for more southern locations in North America. The problem of the mode of deposition of these shells is one of considerable interest.

On August 20 during the course of a foot traverse across the adjacent lowland and up the eastern slope of Hare Cape Ridge at a point about 6 miles south of Slidre Fiord shell fragments and whole pelecypod shells were noted to be locally common at elevations below 300 feet on the comparatively vegetation-free surface of fine silt-sand. It was with some surprise, however, that shell fragments were still found in considerable numbers as the higher parts of the eastern flank of the ridge were climbed. Very small fragments of shell were found, for example, on a steep slope at an elevation of 1,386 feet. (Elevations were obtained by use of a Paulin surveying altimeter and are probably accurate to 20 feet.) Larger and more numerous fragments were found in an area of gently sloping terrain at an elevation of 1,730 feet. Finally, a whole shell and many fragments were found near the crest of Hare Cape Ridge at an elevation of 1,998 feet (approximate position: 79°57' N., 86°22' W.). The shells were found on heavy, black, residual clay containing small pebbles of diabase lying in a small depression on the surface of the intrusive rock that is the ridge-forming bedrock in the area. A few small granitic pebbles were also scattered over the surface of the clay.

On the following day, a traverse was made southward across the lowland south of Slidre Fiord, along the eastern flank of Hare Cape Ridge,

*Ornithologist, now on the staff of the Dept. of Biology, Kansas State Teachers College, Emporia, Kansas.

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and thence to the summit of the same ridge at a point approximately 11 miles south of Slidre Fiord. In the early part of the traverse shells and shell fragments were noted to be widely scattered on the surface of the lowland at elevations below 400 feet. During the ascent of the ridge, shells were found in considerable numbers at elevations of 1,174, 1,286, 1,330, 1,590 and 1,640 feet above sea level. While some of these fragments were found on a silt-sand surface covered with a sparse vegetation of moss, mountain avens and grass, many were found in association with occasional granitic pebbles on heavy, black clay similar to that noted with the highest shells found on the previous day. The shells at 1,640 feet were found near the crest of the ridge which near its southern end (79°50' N.) is several hundred feet lower than at the northern end of the ridge.

Shells taken from near the crest of Hare Cape Ridge at the 1,998-foot elevation have been identified as mainly *Hiatella arctica* and *Mya truncata* and a small sample has recently been carbon-dated by the Lamont Geological Observatory at 19,500 ± 1,100 years B.P. (L548), a considerable age for shells which, superficially at least, appear to postdate the last glacial activity in the area. The Hare Cape Ridge shells may be compared in age with the recently determined radiocarbon age for similar shells found in eastern Axel Heiberg Island by Dr. B. R. Robitaille during the summer of 1960. These shells, found at an elevation of 510 feet near the base of Schei Peninsula 24 miles northwest of Hare Cape Ridge, have been dated by Isotopes Inc. at 8,080 ± 160 years B.P. (I-264, G.B. No. R-62). Craig and Fyles (1960, p. 10-12, 18) give additional information on available radiocarbon dates for materials from Arctic Canada.

Raised marine terraces, strandlines and marine shells at considerable elevations are not unusual in the Queen Elizabeth Islands. Smith (1961, p. 45-6) points out that the general maximum elevation of these features in the northern part of the Queen Elizabeth Islands and in northern Greenland appears to be in the range from 500 to 700 feet and he lists eleven references to reports of such occurrences. Recently Müller (1961, p. 9) has found marine shells near the Eureka weather station at an elevation of 210 m. (700 feet). In addition, moreover, Smith cites three examples of unusually high occurrences of shells in Ellesmere Island and northern Greenland: one at an elevation of 1,800 feet near Polaris Bay, Greenland (Boggild, 1928, p. 248); a second at an elevation of 1,000 feet in the vicinity of Discovery Harbour, Ellesmere Island (Feilden, 1878, p. 67; De Rance and

Feilden, 1878, p. 334); and a third, which is the Hare Cape occurrence discussed above and which was communicated to Smith by M. Marsden who, with the writer, formed a Geographical Branch field party in Fosheim Peninsula in 1955.

In addition to the high-level shell occurrences cited, at least one other find is mentioned in the literature which might be profitably re-examined. This is a shell locality noted by Lockwood and Brainard (Greely, 1888, v. 1, p. 290, 296) on the south shore of Greely Fiord at elevations of 1,500 and 2,140 feet, . . . "On the top of the mountain we found fossilized marine animals and petrified wood and coral in great quantities" (p. 296). The co-ordinates given by Brainard for this find are 80° 48' 05" N., 78° 26' 00" W. These, however, appear to be inaccurate since this location on modern maps falls on the surface of Greely Fiord some distance offshore. The "fossils" were probably found in the vicinity of 80° 48' N., 78° 15' W.

Although Lockwood and Brainard describe the organic remnants which they found as being "petrified wood and the fossil remains of shell-fish, snails, ect." the possibility exists that the shell remains are considerably younger than the other fossilized remnants and are, in fact, contemporaneous with the other high-level shells found in the High Arctic, and noted above.

The discovery of the shells on Hare Cape Ridge, as well as of the others, is significant, and several modes of deposition are possible. Sea birds may have contributed to this distribution. It is the impression of the writer, however, that they could not have exerted more than a local effect. Glacial transport of the shells as a constituent of frozen drift or other unconsolidated material might have allowed some shells to survive in a relatively undamaged condition until they were deposited at the tops of the ridges. Finally, there remains the possibility, suggested by Smith (1961, p. 47), that marine submergence extended well above the elevations usually suggested.

A number of carefully collected and dated samples from various elevations on the sides of Hare Cape Ridge would help to solve the problem of whether the shells were deposited contemporaneously or whether they were progressively deposited down the slope of the ridge, with the result that shells at higher elevations are older than those closer to sea-level.

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SOME TYPES OF LAND USE IN CANADA

B. Cornwall and L. Labelle

Land-use patterns revealed by airphotos reflect variations of soil, the restrictions of slope, and adaptations to both the length of the growing season and the amount of available moisture.

Agricultural land use in Canada has developed over a period of more than 300 years. The earliest recorded farming took place close to the French fort at Annapolis Royal, N.S., soon after its foundation in 1605, to produce food for the garrison. Early in the 18th century a start was made on reclaiming marshlands along the rivers. These proved more fertile than the land above the rivers and with ample precipitation and a growing season averaging 180 to 200 days, successful crops of hay, grain and vegetables were produced. In 1617, on the present-day site of the city of Quebec, the first commercial farming in the St. Lawrence Valley was started, and expanded in a relatively narrow belt along the river. Farming spread slowly because of the difficulty of clearing the forest and the lack of communications between settlements. Land settlement was based on the seigniorial system and in many places, by dividing and sub-dividing, a pattern of long narrow fields resulted. In 1671 a French settlement at Kingston expanded into farmland and spread slowly until the arrival of the United Empire Loyalists after 1780.

Both climate and soils are suitable for farming throughout the St. Lawrence lowland. There is ample rainfall and, though winter and summer temperatures can be severe, the growing season is long. In the western part of the lowland, the lakes have an important tempering effect on the climate that results in a growing season of up to 200 days and permits the production of tree fruits, small fruits and vegetables as well as grains and hay. Farther downstream the growing season is up to 20 days shorter and is more suited to a hay-grain-dairying program.

Western farm settlement started in 1812 at Winnipeg but no expansion occurred until the first transcontinental railway was completed in 1886. Settlers found land that seemed ideal for grain farming, or rolling grass land of tremendous extent, with suitable soils and temperatures and adequate precipitation in the growing season.

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Although much of the prairies is suitable for the production of grain there are arid areas that should have been used for grazing rather than for cultivation. New farming techniques have been devised to combat drought and soil drifting, and in places, irrigation has proved practical.

In British Columbia farming was started in 1810. The west coast has a mild climate, ample rainfall and a growing season of up to 260 days, an ideal environment for fruits, vegetables and dairying, particularly on the fertile soils of the Fraser River delta and on the eastern coast of Vancouver Island. In contrast, the interior of the province is dry and the growing season is less than 200 days. Here ranching can be successful. In some of the southern valleys where irrigation has been developed tree fruit production has proved to be the most suitable form of land use.

QUELQUES MODES D'UTILISATION DES TERRES AU CANADA

B. Cornwall et L. Labelle

L'utilisation des terres telle qu'elle apparaît sur les photos aériennes reflète les variations dans la nature des sols, l'influence restrictive des versants de même qu'une adaptation à la période végétative et au degré d'humidité.

L'utilisation des terres pour l'agriculture au Canada remonte à plus de trois siècles. En effet, c'est à Port-Royal en Acadie, qu'on trouve la première ferme, au lendemain de la fondation, en 1605. Située dans le voisinage du fort construit par les Français, cette ferme servait au ravitaillement de la garnison. Dès le début du XVIII^{e} siècle, on commença à assécher les marais en bordure des rivières. Ces basses-terres, se sont avérées les plus fertiles de la région et ce, grâce à d'abondantes précipitations et à une période végétative de 180 à 200 jours en moyenne; on y faisait alors de riches récoltes de foin, de céréales et de légumes. Dans la vallée du Saint-Laurent l'agriculture commerciale fut d'abord pratiquée dans le voisinage de Québec, à partir de 1617, puis s'étendit peu à peu sur une étroite bande le long du fleuve. Les progrès furent retardés par les travaux de déboisement et le manque de communication d'un village à l'autre. Le partage des terres était basé sur le système seigneurial et les divisions et les subdivisions subséquentes ont donné lieu, en maints endroits, à des séries de champs longs et étroits. Un troisième établissement français fut fondé en 1761, à Kingston, d'où les fermes se répandirent lentement jusqu'à l'arrivée des Loyalistes après 1780.

Les sols des Basses-terres du Saint-Laurent sont relativement fertiles et le climat est partout propice à l'agriculture. Les pluies sont abondantes et bien que les températures en été comme en hiver puissent être rigoureuses, la période végétative est longue. Dans l'ouest de ce secteur, les lacs constituent un élément modérateur du climat de sorte qu'on a une période végétative d'environ 200 jours qui favorise la culture des petits fruits et des légumes en plus des céréales et du foin. Un peu plus en aval, la période végétative, plus courte d'une vingtaine de jours, se prête surtout à la culture du foin et des céréales et à la production laitière.

Les premiers établissements agricoles dans l'Ouest canadien remontent à 1812, à Winnipeg, mais ne connurent guère d'expansion avant l'achèvement du chemin de fer transcontinental en 1886. Les colons trouvèrent

des terres qui semblaient toutes désignées pour la culture des céréales: de vastes prairies onduleuses, des sols apparamment fertiles, des températures clémentes ainsi que des précipitations adéquates durant la période végétative.

Quoique la majeure partie des prairies offre des conditions favorables à la culture des céréales, on y trouve des secteurs arides qui, au lieu d'être mis en culture, auraient dû être consacrés à l'élevage. On a mis au point de nouveaux procédés pour parer aux effets de la sécheresse et empêcher l'érosion éolienne; en certains endroits, on y pratique l'irrigation.

En Colombie-Britannique, l'agriculture remonte à 1810. Le littoral du Pacifique jouit d'un climat doux aux pluies abondantes et la période végétative est d'environ 260 jours. Toutes ces conditions sont favorables à la culture des fruits et des légumes de même qu'à l'industrie laitière, en particulier sur les sols fertiles du delta du fleuve Fraser et de la côte est de l'île Vancouver. Par contre, dans l'intérieur le climat est sec et la période végétative ne dépasse pas 200 jours. Toutefois, ce milieu se prête bien à l'élevage intensif. Dans quelques-unes des vallées du sud de la province, où l'on pratique l'irrigation, la culture des fruits d'arbre s'est avérée la forme la plus profitable d'utilisation des terres.


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Dykeland - Cornwallis River, N.S. Early in the 18th century the Acadian colonists of Nova Scotia first reclaimed marshland from the sea by building wood and mud dykes. Modern methods of building dykes, aboideaux, sluices and breakwaters have improved technically but the fundamental principles have remained the same for over 200 years. Dykelands, where the soils are silty clay loams and clay loams, are highly suitable for the cultivation of grains and hay, and afford excellent pasture after the hay has been removed. Virtually all the dykelands of the region are operated on a cooperative basis by groups of farmers who usually have most of their farm land on the well drained land above the rivers, where the soils are primarily loams and sandy loams. Most common uses are orchards, root crops such as potatoes and turnips, hay fields and permanent pasture. The average length of the growing season throughout the valley is 180 to 200 days.

Port Williams, N.S. Scale, 1 inch: 1,200 feet. Airphoto No. A 8646-37

Terrains endigués - Rivière Cornwallis (N.-É.). Dès le début du XVIII[e] siècle les marais furent conquis sur la mer par les colons Acadiens au moyen de digues faites de bois et de terre. Aujourd'hui, digues, aboiteaux, écluses et brise-lames sont construits selon des méthodes perfectionnées, mais les principes fondamentaux sont les mêmes qu'il y a deux siècles. Les terrains endigués, dont les sols sont constitués de terres franches argileuses et argileuses-limoneuses, se prêtent merveilleusement à la culture des céréales et du foin et constituent d'excellents pâturages après la récolte du foin. La presque totalité des terrains endigués de la région est exploitée en coopérative par des groupes de fermiers dont la plupart de leurs terres sont au-dessus du niveau des rivières, en terrain bien égoutté et où les sols sont formés principalement de terres franches et de terres franches sableuses. On y trouve surtout des vergers, des champs de tubercules tels les pommes de terre et les navets, des champs de foin et des pâturages permanents. La période végétative moyenne dans toute la vallée varie entre 180 et 200 jours.

Port Williams (N.-É.). Échelle, 1,200 pieds au pouce. Photo aérienne n° A 8646-37

Prince Edward Island. Dairying is the principal form of agriculture in this section of farmland northwest of Charlottetown. The average length of the growing season is between 180 and 200 days, and the soils are a fine sandy loam derived from red or brown sandstone. Pasture, hay and grain—mainly oats—occupy most of the improved land. The remaining acreage is devoted to potatoes, the only important cash crop in the area. Fields are small, from 5 to 10 acres, and are bordered by tall coniferous hedgerows which typify the island landscape.

Scale, 1 inch : 1,200 feet. Airphoto No. A 16113-24

Île-du-Prince-Édouard. Dans ce secteur agricole, au nord-ouest de Charlottetown, l'agriculture est orientée vers l'industrie laitière. La période végétative moyenne varie entre 180 et 200 jours, et les sols sont formés de terre franche sableuse fine, dérivée de grès rouges ou bruns. La plupart du terrain défriché est consacré au pâturage, au foin et aux céréales—surtout l'avoine. Le reste est planté de pommes de terre, la seule culture marchande de quelque importance en cette région. Les champs sont de dimensions réduites—5 à 10 acres—et bordés de haies de grands conifères, ce qui prête au paysage de l'île un air caractéristique.

Échelle, 1,200 pieds au pouce. Photo aérienne n° A 16113-24

97943-5—9

Quebec—St. Lawrence Lowland. The long, narrow fields, typical of the province of Quebec, have evolved from the seigniorial system of land grants in the early settlement period, under which large tracts of land were granted. Subsequently the seigniories were divided to accommodate as many tenants or heirs as possible, each owning frontage on the river, the main communication route at the time. The area shown is in Lotbinière county, which has predominately clay soils varying from well to poorly drained, and a growing season averaging 160 to 180 days. Dairy farming is the major occupation, associated with the cultivation of oats and hay and corn for fodder.

Scale, 1 inch : 1,000 ft. Airphoto No. A 14601-28

Québec—Les Basses-terres du Saint-Laurent. La configuration typique des champs de la province de Québec, longs et étroits, résulte du système seigneurial des débuts de la colonie. Par la suite, les seigneuries furent divisées afin de pourvoir aux besoins d'un plus grand nombre de tenanciers et d'héritiers. Ces lopins de terre donnaient sur le fleuve, lequel était alors la principale artère de communication. Le secteur que montre la photographie est situé dans le comté de Lotbinière où les sols sont formés principalement d'argile dont l'égouttement varie de bon à mauvais et où la période végétative moyenne est de 160 à 180 jours. La principale occupation est l'industrie laitière qui requiert la culture de plantes fourragères telles l'avoine, le foin et le maïs.

Échelle, 1,000 pieds au pouce. Photo aérienne n° A 14601-28

Ontario. The coastal plain of Lake Erie, inundated in glacial times, has the characteristic flatness of ancient lake bottoms. The soils are mainly gravelly loams and clay loams. The favorable climate, with an average growing season of over 200 days, permits the cultivation of soft fruits and the early harvesting of vegetables. Other crops in the region are winter wheat, soybeans, tobacco and corn.

Cedar Spring, Ont. Scale, 1 inch : 3,100 ft. Airphoto No. A 16532-138

Ontario. La plaine côtière du lac Érié, inondée durant l'époque glaciaire, est, comme tout ancien fond de lac, dépourvue de relief. Les sols sont formés principalement de terres franches graveleuses et de terres franches argileuses. Le climat tempéré, avec une période végétative moyenne dépassant 200 jours, favorise la culture des fruits rouges et la récolte hâtive des légumes. Dans cette région on cultive aussi le blé d'automne, le soya, le tabac et le maïs.

Cedar Springs (Ont.). Échelle, 3,100 pieds au pouce, Photo aérienne n° A 16532-138


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The Clay Belts. These farmlands are a part of a large drift area on the Precambrian Shield, with soils that resemble those of agriculturally developed areas elsewhere in Canada. However, there are chemical differences in that much of the Clay Belt drift was derived from Precambrian rock formations, whereas in other agricultural areas most of the drift was derived from sedimentary rocks. The growing season averages 140 to 160 days. Many of the farms are used only as a residence and support perhaps a cow, some pigs, chickens, and a vegetable garden, the products of which are consumed on the farm. Dairy products are the chief source of income and the principal markets are within the Clay Belt and the neighboring gold mining area.

Palmarolle. Scale, 1 inch : 5,600 ft. Airphoto No. A 13452-9

La zone d'argile—Ces terres agricoles font partie d'une grande nappe de débris morainiques sur le Bouclier canadien. Les sols de cette région ressemblent à ceux d'autres régions agricoles du Canada, à la différence que les débris morainiques de la zone d'argile sont dérivés de roches précambriennes tandis que ceux d'autres régions agricoles sont dérivés, pour la plupart, de roches sédimentaires. La période végétative moyenne varie entre 140 et 160 jours. Un grand nombre des fermes tiennent lieu de résidence seulement; on y garde parfois une vache, quelques porcs, des poules et on cultive un potager, le tout pour fins de consommation domestique. Les produits laitiers constituent la principale source de revenu, et les marchés locaux sont situés dans la zone d'argile et la région d'exploitation minière avoisinante.

Palmarole. Échelle, 5,600 pieds au pouce. Photo aérienne n° A 13452-9

Manitoba—Red River Valley. The Red River Valley lies in the bed of glacial Lake Agassiz and its relief is remarkably level. Soils of the area are black earth of varying textures from medium loam to heavy clay, of good depth, fertile and stone-free. With a growing season of 160 days this is a particularly good region for grain growing and for special crops such as sugar beets, sunflowers and corn and is ideally suited for garden crops. Associated with the lack of relief is the problem of drainage and flooding. Many of the early settlers were German and Dutch Mennonites. French, English, Scottish and Irish settlers have helped in the development of this area.

South of Winnipeg. Scale, 1 inch : 1,320 ft. Airphoto No. A 11667-97

Manitoba—La vallée de la rivière Rouge. La vallée de la rivière Rouge, sise sur le fond du lac glaciaire Agassiz, est dépourvue de relief. Les sols de la région consistent en terres noires de texture variable, à partir de terres franches moyennes jusqu'à l'argile compacte; ils sont passablement épais, fertiles et exempts de pierres. Avec une période végétative de 160 jours, cette région se prête admirablement à la culture des céréales et à certaines cultures spécialisées comme la betterave à sucre, le tournesol, le maïs, en plus d'offrir des conditions idéales pour la culture maraîchère. L'absence de relief pose certains problèmes de drainages et entraîne un danger d'inondation. Un grand nombre des premiers colons étaient des Allemands et des Hollandais mennonites. Des colons français, anglais, écossais et irlandais ont aussi contribué au développement de cette région.

Au sud de Winnipeg. Échelle, 1,320 pieds au pouce. Photo aérienne n° A 11667-97

97943-5—10

Saskatchewan—Regina Plain. In contrast to the semi-arid area farther west (below), the Regina plain offers a different field pattern. More available moisture and the heavier texture of the soil (heavy clay) make unnecessary the excessive measures to retain moisture or to prevent soil drifting which are essential in the semi-arid area. As a result larger land units are under crops and a checker-board pattern is provided by the fallow and sown fields. Practically the entire area is devoted to grain. Livestock may be a secondary farm activity. In this area the grain has been swathed, that is, cut and left in rows in the fields. This is usually done in late summer to avoid damage to standing grain by hail, certain diseases, and pests. At harvest time it is 'combined' in the same manner as standing grain. This is a typical small, prairie settlement with a street pattern oriented to the railway, grain elevators along the tracks, a small commercial area and a large curling rink.

Gray, Sask. Photo No. GB S-5

Saskatchewan—La plaine de Regina. La disposition des champs dans la plaine de Regina diffère de celle de la région semi-aride plus à l'ouest (photo 8). La région est plus humide et le sol plus compact (argile compacte) de sorte qu'on n'a pas, comme dans le secteur semi-aride, à prendre des mesures extrêmes pour conserver l'humidité et empêcher l'érosion éolienne. Il s'ensuit que les champs cultivés sont plus grands et que l'alternance des jachères et des semis leur confère la forme d'un damier. La presque totalité de la région est consacrée aux céréales. En certains cas, l'élevage constitue une occupation secondaire. Dans ce secteur, les grains sont en andains. On fauche ainsi vers la fin de l'été afin de parer au dommage par la grêle, les maladies ou les insectes. Au temps de la moisson, ces grains seront récoltés de la même manière que les grains non fauchés, au moyen de moissonneuses-batteuses. Le petit village, qui apparaît sur la photographie, avec son réseau de rues orientées vers la voie ferrée, ses silos de blé en bordure de la voie, son petit quartier des affaires et sa grande salle de curling, est très réprésentatif du village type des Prairies.

Gray (Sask.). Photo n° GB S-5

Alberta—Semi arid area strip farming. Strip cropping consists of the cultivation of at least four strips of summer fallow and sown crop per half mile. Its use shows that soil, climatic and other factors necessitate measures to retain moisture and to prevent soil drifting. In addition to conserving moisture in the fallow strips, soil drifting is impeded by the increase in weight of the soil particles and by having the strips oriented at right angles to the prevailing wind thus reducing its fetch across unprotected soil. Further protection can be achieved by planting shrubs or trees along field borders or even along the edges of individual strips. It can be seen that about 50 per cent of the land is fallow representing a two-year crop-fallow rotation. This area is devoted almost exclusively to wheat plus small acreages of barley and oats.

Champion, Alta. Scale, 1 inch : 3,400 ft. Airphoto No. A 15109-1

Alberta—Culture en bandes, en terrain semi-aride. La culture en bandes consiste à alterner la jachère et le semis à raison d'au moins quatre bandes au demi-mille. Cette méthode de culture, qui vise à retenir l'humidité du sol et empêcher l'érosion éolienne, est rendue nécessaire par la nature du sol, du climat et autres facteurs. En orientant les bandes perpendiculairement au vent dominant, on réduit la distance que le vent doit parcourir au-dessus du sol nu et on réduit du même coup l'érosion éolienne du sol déjà appesanti par l'humidité retenue dans les bandes de jachère. Par mesure de protection additionnelle, on plante parfois des buissons ou des arbres en bordure des champs ou même en bordure de chaque bande. Comme le montre la photographie, 50 p. 100 du terrain est en jachère, ce qui indique un assolement biennal. A part quelques acres d'orge et d'avoine, cette région est consacrée presque exclusivement au blé.

Champion (Alb.). Échelle, 3,400 pieds au pouce. Photo aérienne n° A 15109-1


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Alberta—Semi arid area irrigation. Low moisture content of the soil, the unreliability of precipitation and its low total (11 to 13 inches a year) are serious handicaps to farming in this area. Irrigation is essential for any agricultural use other than ranching and is apparent in the sharp contrast between irrigated and non-irrigated lands. The success of irrigation in the semi-arid area, where the growing season averages 180 days, is illustrated by the increase in irrigated acreage in Alberta from 500,000 acres in 1953 to over 845,000 acres in 1959. As in other prairie regions, wheat, barley and oats are important. Other crops are flax, sugar beets and alfalfa for fattening cattle.

About 50 miles west of Medicine Hat. Scale, 1 inch : 3,400 ft. Airphoto No. A 15109-106

Alberta—Irrigation en terrain semi-aride. La sécheresse du sol, la pénurie (11 à 13 pouces par année) et la variabilité des précipitations sont autant de facteurs qui créent de sérieuses difficultés à l'agriculture en cette région. Au contraste frappant entre les terres arrosées et celles qui ne le sont pas, on voit que l'irrigation est ici essentielle à toute forme d'agriculture autre que l'élevage intensif. Le fait que la superficie irriguée en Alberta soit passée de 500,000 acres à 845,000 acres de 1953 à 1959 montre assez les avantages de l'irrigation en terrain semi-aride où la période végétative moyenne est de 180 jours. Le blé, l'orge et l'avoine occupent ici, comme en d'autres secteurs des Prairies, une place de choix. On cultive en outre la luzerne pour l'engraissage du bétail, le lin et la betterave à sucre.

Environ 50 milles à l'ouest de Medecine Hat. Échelle, 3,400 pieds au pouce. Photo aérienne n° A 15109-106

British Columbia—Okanagan Valley. The Okanagan Valley accounts for 93 per cent of the total apple and pear production of British Columbia and almost all the peach production. Orchards have strict climatic requirements that influence their location. Because of low annual precipitation, they are limited to irrigable land; they are located in areas where the growing season is long, and here it averages up to 200 days; in order to achieve some protection from frost by air drainage, they are often located on sloping ground above the valley floors or, as in the area shown, on bench lands above the lake which acts as a temperature regulator. The distinct line at the edge of the orchard area indicates the beginning of the steep slope where irrigation ends.

Penticton, B.C. Scale, 1 inch : 2,300 ft. Airphoto No. A 11654-373

Colombie-Britannique—Vallée de l'Okanagan. La vallée de l'Okanagan fournit 93 p. 100 de la récolte de pommes et de poires et la presque totalité de la récolte de pêches de la Colombie-Britannique. Les vergers sont très sensibles au climat et doivent être situés en conséquence. A cause de la pénurie de précipitation ils doivent être placés en terrain irrigable. La période végétative doit être de longue durée; elle dépasse ici 200 jours. Les vergers doivent également être protégés de la gelée. En conséquence ils occupent souvent le flanc des vallées où la circulation de l'air s'effectue facilement, ou encore, comme le montre cette photographie, les terrasses voisines d'un lac qui réduit les écarts de température. La ligne distincte qu'on voit en bordure de l'aire du verger indique une rupture de pente qui correspond à la limite du terrain irrigable.

Penticton (C.-B.). Échelle, 2,300 pieds au pouce. Photo aérienne n° A 11654-373

British Columbia—Lower Fraser Valley. The lower Fraser River valley has a mild climate and a growing season of up to 260 days. Dairy farming is one of the main agricultural activities, most of the production being consumed as fresh milk in the Vancouver area. Other farm activities are the production of grain, vegetables, grapes, hops and small fruits. The extraction of peat is a second important commercial activity in parts of the region. A striking feature of this area is the suburban sprawl invading the agricultural land.

Lulu Island, B.C. Scale, about 1 inch : 2,900 ft. Airphoto No. A 15948-60

Colombie-Britannique—La vallée inférieure du Fraser. La vallée inférieure du Fraser jouit d'un climat tempéré et la période végétative est de 260 jours. L'agriculture est orientée principalement vers l'industrie laitière pour le marché de la région de Vancouver. On y cultive, en outre les céréales, les légumes, la vigne, le houblon et des petits fruits. En certains endroits, on exploite des tourbières. L'envahissement des terres agricoles par l'urbanisation est l'un des phénomènes les plus frappants de cette région.

Lulu Island, (C.-B.). Échelle, environ 2,900 pieds au pouce. Photo aérienne n° A 15948-60

MAP NOTES—FICHES CARTOGRAPHIQUES

Land Use of Southern Ontario. 1:1,000,000. Atlas of Canada, plate S1. Dept. Mines & Tech. Surv., *Geog. Br.*, Ottawa, 1960. Price 50 cents.

This is the first supplementary sheet to be added to the Atlas of Canada and is the first Canadian land-use map published at 1:1,000,000. The scale, land-use categories, and colors are in keeping with the directives set forth in 1952 by the Commission on World Land Use Survey. Sixteen categories are differentiated: 3 urban (industrial and commercial, residential, and associated urban), 6 agricultural (horticulture, orchards and vineyards, hay, grain and soybeans, tobacco, improved pasture, and unimproved grazing land), 4 woodland (dense, open, scrub, and cut-over or burnt-over), unproductive land, swamps and marshes, and lakes and rivers. The boundaries of national and provincial parks, provincial forest preserves, areas under crown timber licences, and principal Indian Reserves are also shown, to assist in the interpretation of the land-use information.

Since land-use data had been field-mapped for only limited sections of southern Ontario, a variety of additional sources were used in compiling the land-use map. Forestry information was generalized from the recent provincial forest inventory. The agricultural data was derived primarily from the 1956 census of agriculture, and plotted with the assistance of soils maps, university theses, conservation authority reports, and all other available sources. As a high degree of generalization is necessary in plotting field-mapped data on the small scale map, it was considered that the use of good statistical data in conjunction with other geographical information would produce an accurate result at the 1:1,000,000 scale.

C.W.R.

Economic Atlas of Manitoba (ed. Dr. T. R. Weir), *Manitoba Dept. Industry and Commerce,* 1960. Price $20.

This represents a significant addition to the atlases of Canadian provinces and to geographic knowledge. Dr. Weir has organized the atlas into three parts: Resource Base, Population and Settlement, and Resource Use. The resource base section contains 10 maps of physical geography, ranging in subject matter from hypsography to geology and natural vegetation.

The population and settlement section contains maps that deal with rural, urban, indigenous, and ethnic population distributions as well as with historical settlement (1870 to 1921), routes of travel, and population trends. Each of these maps is accompanied by a page of text that greatly assists interpretation. The last section, resource use, is the largest, and contains 20 maps, 7 of which deal with farm economy, 2 with game birds and big game, and big game and fur bearers, and 11 with Manitoba's industrial economy and urban population.

The atlas' major contribution lies in its portrayal of population and economic activities. A number of population maps are of interest to geographers, particularly the 6 maps of the historical settlement (1870–1921) that provide a concise summary of the evolution of Manitoba's settlement. The maps of native people and ethnic groups (British, Ukrainian, French, Mennonite, Scandinavian, Polish and German) based on the 1951 Census of Canada, serve to demonstrate the location of the different elements of Manitoba's population. The atlas includes the urban land use and daytime population maps of Winnipeg, compiled by the Geographical Branch in the summer of 1953–1955,

The economic data is well presented and provides the reader with an excellent areal summation of Manitoba's economy. The rural economic maps are concerned with the extent of types of farming, the distribution of crops and animals, the value of farm land and buildings, implements and machinery, and livestock, as well as farm tenure, size, and number. The industrial economic maps range from electrical power to transportation to manufacturing. In particular, the forestry maps are excellent, indicating the administrative control, reserves of timber, and commercial exploitation.

R.M.B.

THE SOUTHERN PORTION OF OF THE PROVINCE MANITOBA, (49N.–54N.). 1:506,880. *Manitoba Dept. Mines and Natural Res.*, Winnipeg, 1960.

Published in color, this map shows municipalities, local government districts, and provincial parks and forest reserves. Also shown are the sectional survey lines and cultural features.

J.W.M.

MANITOBA. 1:1,267,200. *Manitoba Dept. Mines and Natural Res.*, Winnipeg, 1959.

This map is a revision of the 1956 edition. In addition to showing roads, railroads, and settlements, it indicates provincial parks and forest reserves.

J.W.M.

PHYSIOGRAPHIC DIVISIONS OF SASKATCHEWAN, (Map 1). 1:520,640. *Saskatchewan Res. Council*, Saskatoon, 1960.

This multicolored map is the result of the cooperative efforts of the Saskatchewan Soil Survey, the Geology Division of the Saskatchewan Research Council and the Geology Department of the University of Saskatchewan. The province has been broken down into a total of 46 physiographic units, thus providing the most detailed physiographic map of Saskatchewan published to date. Tabulated characteristics of each division have been presented, giving data on topography, landforms, elevation, and surficial and bedrock geology. The publishers have used a base map drawn by the Geological Survey of Canada that shows topographical data as well as the sectional survey lines.

J.W.M.

PROVINCE OF ALBERTA. 1:760,320. (2 sheets, north and south). Alberta *Dept. Municipal Aff.*, Edmonton, 1960.

This map is the latest edition of a general map of Alberta showing administrative divisions, provincial parks and reserves. The main transport routes and other cultural features are indicated as well as the sectional survey lines.

J.W.M.

ALBERTA AND NORTHEASTERN BRITISH COLUMBIA, (Map 1039 A). 1:1,520,640. *Geol. Surv., Canada*, Ottawa, 1960.

This map, the seventh edition, incorporates information available up to Dec. 31, 1959, and was compiled mainly from information published by provincial authorities and data supplied by pipeline companies. The map shows oil and gas fields, oil and gas discoveries, and oil and gas pipelines (existing, planned in 1960 and proposed); in addition, areas of bituminous sands are indicated. Both oil refineries and natural gas processing plants are identified.

J.W.M.

BRITISH COLUMBIA; relief map. (Map IJR). 1:1,900,080. *British Columbia Dept. Lands and Forests*, Victoria, 1960. Price $1.00.

Produced in six colors, this is the first edition of a hypsometric relief map based on the 1-inch-to-30-mile-scale, one-sheet map of British Columbia published in 1957. Generalization of relief has been kept to a minimum and accuracy has been enhanced by compiling the relief data from published and unpublished 1-inch-to-2-mile and 1-inch-to-4-mile National Topographic series maps. Topographic detail (lakes, rivers, railroads, place names, etc.) shown, is derived from the 1957 1-inch-to-30-mile map of British Columbia. (Map IJ). Two inset maps at reduced scale show the distribution of annual precipitation and the physiographic sub-divisions of the province.

J.W.M.

BOOK NOTES—FICHES BIBLIOGRAPHIQUES

REPORT OF ROYAL COMMISSION ON COAL. The Hon. I. C. Rand, Q.C., Commissioner. *Queen's Printer*, 127 p., 1960. Price $2.00.

The Rand report provides an objective discussion on the present condition of the Canadian coal industry with particular emphasis on the Cape Breton area where problems are most acute. It recommends a system of subsidies designed to improve the competitive position of coal in local markets, also a graduated reduction in the production of DOSCO's Nova Scotia mines to 3 million tons annually during the next 10 years. An intensification of scientific research on problems of coal production and utilization is recommended. A series of appendices list data on coal production and consumption, and federal government assistance to the industry.

[C.W.R.]

A SURVEY OF THE URANIUM INDUSTRY IN CANADA, 1959. J. W. Griffith. Dept. Mines and Tech. Surv., *Mineral Resources Div.*, Min. Inf. Bull. MR 44, Ottawa, 1960. 46 p., maps, illus. Price 50 cents.

This bulletin summarizes developments in the uranium industry in 1959. Statistics of production for 1958 and 1959, ore reserves, and future prospects are included for each of the producing properties. Maps are included showing the location of each property. A brief outline of the production of thorium is also given.

[J.B.M.]

INDUSTRIAL WATER RESOURCES OF CANADA, THE ATLANTIC PROVINCES, AND THE SAINT JOHN RIVER DRAINAGE BASINS IN CANADA, 1954–56. J. F. J. Thomas. *Mines Br.*, Water Surv. Rept. no. 11, Ottawa 1960. 158 p., tables, maps, append.

This report is the eleventh in a series on the chemical quality of surface and municipal water supplies available for industrial and domestic use in Canada. In tabulated form the report presents data on: chemical analyses of surface water; municipal water systems; and chemical analyses of civic water supplies Tables on municipal water supplies in the drainage basins, and area and population statistics are also presented.

[J.W.M.]

THE PLANTS OF PRINCE EDWARD ISLAND. David S. Erskine. Dept. Agric., *Research Br.*, Plant Res. Inst. Ottawa, 1960. 270 p., maps photos. Price $1.50.

The ranges of flora in Prince Edward Island are generally uniform with a few plants isolated to the western part of the province, and with others as yet restricted in their potential habitats. These facts, as well as the information that two plants are not known in the neighbouring provinces, are of phytogeographic interest. Moreover, many plants found on the mainland do not occur in Prince Edward Island because the Island's habitat is generally unsuitable for aquatics, intervale plants and geophytes. The author draws the conclusion that "there is little or no positive evidence of the significance of the land bridge in the migration of present flora to the Island." A fold-out map assists in orientation and site determination. In addition there are 809 "minimaps" showing the location of many of the 954 species and hybrids and of the 82 varieties found and described by the author and his predecessors.

[J.A.R.]

THE GLACKMEYER REPORT OF MULTIPLE LAND-USE PLANNING *Ont. Dept. Lands and Forests*, Toronto, 1960. 210 p., maps, photos, graphs, tables.

Written in non-technical language, this excellent report presents a practical solution to land-use problems in the Cochrane clay belt. Each of the main sections of the report dealing with the agricultural, forestry, wildlife, and recreational land-use plans has been written as a unit that can be read either separately, or as part of the integrated multiple land-use plan. As a whole, the report shows a fundamental approach to land-use planning that has a broad application to rural settlement.

[B.C.]

GRAVITY AND ISOSTASY IN NORTHERN ONTARIO AND MANITOBA. M. J. S. Innes. *Dom. Obs. Pub.*, v. XXI, no. 6, Ottawa, 1960. 75 p., maps, tables.

This report presents the results of all gravimeter observations made by the Dominion Observatory in the Canadian Shield of northern Ontario and northern Manitoba south of 57° between the years 1947 and 1955. The results are given in the form of Bouguer and Hayford isostatic anomaly maps and in tables. It is shown that a large part of the gravity anomalies within the area are due to variations in the densities of the surface rocks. Analysis of the isostatic anomalies indicates that there may be incomplete isostatic adjustment following deglaciation in the Hudson Bay area.

[J.B.M.]

PRECAMBRIAN GEOLOGY OF ARCTIC CANADA, A SUMMARY ACCOUNT. R. G. Blackadar and J. A. Fraser. *Geol. Surv., Canada*, Ottawa, 1960, Paper 60-8, 24 p., tables. Price 50 cents.

A discussion of the Precambrian geology of the Arctic Archipelago (Part I, Blackadar) is divided into sections on the older Archæan rocks which predominate in the east, and on the Proterozoic rocks that outcrop chiefly in the western Arctic. The Precambrian of the Arctic mainland (Part II, Fraser) includes summaries of the Archæan and younger Proterozoic rocks, the latter being discussed under six regional headings: Nonacho Lake—Taltson River; Great Slave Lake; Coppermine River; Great Bear Lake—Arctic Coast; Bathurst Inlet; and Baker Lake—Thelon River. Faults and correlation are also discussed and a brief section on economic geology follows both parts I and II. Each part has a list of references and is illustrated with charts and tables.

[P.L.H.]

SUMMARY ACCOUNT OF STRUCTURAL HISTORY OF THE CANADIAN ARCTIC ARCHIPELAGO SINCE PRECAMBRIAN TIME. R. Thorsteinsson and E. T. Tozer. *Geol. Surv., Canada*, Ottawa, Paper 60-7, 25 p., maps. Price 50 cents.

The writers have divided the archipelago into seven structural provinces: a small Tertiary volcanic province in southeast Baffin Island; the Canadian Shield; the Arctic Lowlands; the Franklinian geosyncline; the Sverdrup Basin; the Prince Patrick uplift; and the Arctic Coastal Plain. The structural history of the lowlands and arches in chronological sequence is followed by discussions of the Palaeozoic movements of the eugeosynclinal belt, the development of the Sverdrup Basin, and the Tertiary movements and structures. The paper concludes with a brief discussion of normal faults in the archipelago, and is illustrated by maps showing the structural provinces, tectonics and isopachs as well as a diagrammetric section across the Sverdrup Basin.

[J.K.F.]

GEOLOGICAL INTERPRETATION OF AEROMAGNETIC PROFILES FROM THE CANADIAN ARCTIC ARCHIPELAGO. A. F. Gregory and others. *Geol. Surv., Canada*, Ottawa, 1960, Paper 60-6. 13 p. maps, graphs. Price 50 cents.

The results of an airborne geophysical survey carried out in 1955 in the Arctic Archipelago are briefly discussed in this paper. After listing six types of geological environment where ferromagnetic bodies are known to occur, a short outline of the method of interpretation is given. The magnetic features of the basement and related basins of sedimentary rocks, the Paleozoic fold belts, the Sverdrup Basin, and the Arctic Coastal Plain and the continental shelf, are summarized. Aeromagnetic anomalies over gypsum domes are considered. Five figures, consisting of maps and graphs, illustrate the paper.

[P.L.H.]

HELICOPTER OPERATIONS OF THE GEOLOGICAL SURVEY OF CANADA. *Geol. Surv., Canada,* Ottawa, 1959, Bull. 54, 60 p., illus., tables. Price 75 cents.

The history of the helicopter in the service of the Geological Survey is discussed. The nine helicopter-supported operations undertaken since the inception of their use in 1952 are outlined by each of the geologists involved, and organized under the following subheadings: Introduction, Organization, Field operations, Costs, Conclusions, and References. Tables showing operational data, photographs, and maps illustrate the bulletin.

[P.L.H.]

AN ARCHAEOLOGICAL ANALYSIS OF EASTERN GRANT LAND, ELLESMERE ISLAND, NORTHWEST TERRITORIES. Moreau S. Maxwell. Dept. Northern Aff. National Res., Ottawa, *National Mus.* Bull no. 170, Anthropo. ser. no. 49, 109 p., maps, illus. Price $1.50.

This research, carried out in the summer of 1958, was a contribution to Operation Hazen of the Defence Research Board. After describing the geographical environment, the report gives a description of the 35 sites examined, and the artifacts found in them This is followed by sections on the cultural interpretations and chronological assessments, and ends with a summary and the conclusions drawn from the field work.

[K.C.A.]

PERMIAN ROCKS AND FAUNAS OF GRINNELL PENINSULA, ARCTIC ARCHIPELAGO. P. Harker and R. Thorsteinsson. *Geol. Surv., Canada,* Ottawa, 1960, Mem. 309, 89 p., illus. Price $2.00.

This report describes the Permian rocks and faunas of Grinnell Peninsula where the section consists of two highly fossiliferous formations. The older formation, the Belcher Channel, which is mainly limestone, rests with angular unconformity on the Ordovician and contains fossils mainly of Artinskian age. The younger formation, the Assistance, consists of weakly consolidated glauconite sandstones, and is transgressive. Although it contains an abundant and well-preserved fauna, it cannot be readily assigned to any well-established marine Permian stage and is referred to the Svalbardian, recently proposed for marine equivalents of the Kungurian and lying between the Artinskian and the Kazanian.

[D.S.]

OPERATION HAZEN. THE VEGETATION AND MICRO-CLIMATE OF THE LAKE HAZEN AREA, NORTHERN ELLESMERE ISLAND, N.W.T. J. M. Powell. Arctic Met. Res. Group, McGill Univ., *in* Meteorology no. 38, Dept. National Def., *Def. Res. Bd.,* Ottawa, 1961, 112 p., illus., tbls., diags., mimeo.

OPERATION HAZEN. THE GEOMORPHOLOGY OF THE LAKE HAZEN REGION, N.W.T. D. I. Smith. Geog. Dept., McGill Univ., Misc. Paper no. 2, Dept. National Def., *Def. Res. Bd.*, Ottawa, 1961, 100 p., illus., tbls., diags., mimeo.

Further results of the 1957 and 1958 IGY studies at Lake Hazen, Ellesmere Island (see *Geog. Bull* 15, p. 92 Geog. Br., Dept. Mines & Tech. Surv.) are contained in these reports. The relationship between vegetation and climate is discussed in Powell's report, which contains chapters on micro-climate, soil climate and vegetation conditions. An appendix lists the vascular plants collected during two field seasons. The reports on geomorphology includes a brief outline of structure and bedrock geology, followed by discussions of glaciation of the archipelago, the movements of local glaciers, geomorphological evolution of the landscape and geomorphological processes. The report contains an appendix of observations on soil conditions during snow melt. Both reports are illustrated with photographs and diagrams and supplemented by extensive bibliographies.

[J.K.F.]

SOME PHYSICAL OCEANOGRAPHIC FEATURES OF SOUTH-EAST HUDSON BAY AND JAMES BAY. E. H. Grainger. *Fisheries Res. Bd.*, Montreal, 1960, Ms. Rept. Ser., no. 71, 41 p.

The salinity, temperature, and currents of the waters of southeast Hudson Bay and James Bay as recorded during investigations in 1958 and 1959 are presented. Data from 60 stations, tabulated in an appendix, are used to illustrate the work. Other aspects considered are the underwater topography, ice conditions, tides, and the oxygen and inorganic nutrient content of the water. Descriptions of seven selected section profiles are given.

[P.L.H.]

A PALYNOLOGICAL AND GEOLOGICAL STUDY OF PLEISTOCENE DEPOSITS IN THE JAMES BAY LOWLANDS, ONTARIO. J. Terasmae and O. L. Hughes. *Geol. Surv., Canada*, Ottawa, 1960, Bull. 62, 15 p., map., diags.

This report describes some recent work on the Pleistocene stratigraphy of the James Bay lowlands and the palynological analysis of samples from various localities in that area. The sequence of Pleistocene deposits described consists of a lower and middle drift, overlain by peats, silts and clays which are assigned interstadial rank on the basis of the palynological evidence. Radiocarbon dating of these peats, clays and silts, referred to as the Missinaibi beds, suggest a probable age of more than 53,000 years.

Above the Missinaibi beds lies an upper glacial drift of the main Wisconsin glaciation, in turn overlain by fossiliferous marine clays and postglacial deposits. Palynological studies of the postglacial deposits show that the present vegetation of the James Bay lowlands is similar to that in existence during the deposition of the Missinaibi beds. Five pollen diagrams illustrate this study.

[G.F.]

SURFICIAL GEOLOGY OF NORTH-CENTRAL DISTRICT OF MACKENZIE TERRITORIES, B. G. Craig. *Geol. Surv., Canada*, Ottawa, 1960, Paper 60-18, 8 p., map, tbls. Price 50 cents.

Following a brief description of the surficial features of the area, are discussions of the pattern of ice-retreat, proglacial lakes, marine submergence, radiocarbon age determinations and pingos. Tables list the distribution of Pleistocene fossils and radiocarbon dates. The surficial geology is plotted on a map at a scale of one inch to 16 miles (Map 24–1960). The report is based on field work in 1959 with Operation Coppermine, and airphoto compilation.

[J.K.F.]

Uppermost Jurassic and Cretaceous Rocks of Aklavik Range, Northeastern Richardson Mountains, Northwest Territories. J. A. Jelezsky. *Geol. Surv., Canada*, Ottawa, 1960, Paper 59-14, 31 p., maps. Price 50 cents.

This paper presents the principal results of the work completed during the 1958 field season, and includes chapters on stratigraphy and age, structural geology, and economic geology. It supplements the writer's findings of the 1955 field season, published in G.S.C. Paper 58–2.

[W.E.S.H.]

Soils in Some Areas in the Mackenzie River Delta Region. J. A. Pihlainen, and others., National Res. Council, *Div. Building Res.*, Tech. Paper no. 43, Ottawa, 1956, 26 p., maps, tbls., illus. Price 75 cents.

This report summarizes the results of field work conducted during 1954 in connection with the survey for a new townsite in the Mackenzie River delta. The region lies within the zone of permafrost where construction is costly due to the high ice content in the deltaic silts. Investigations were carried out at Aklavik, along the West and Husky channels and along the eastern side of the delta. A description of the topography, soils and vegetation at each site is given. The survey conducted a drilling program to an average depth of 25 feet. Soil and permafrost analyses include data on grain size distribution, ice content, organic content, plasticity, unit weight and ice segregation.

[W.E.S.H.]

Marine Infaunal Benthos in Arctic North America. Derek V. Ellis. *Arctic Inst. North America*, Tech. Paper no. 5, 1960, 53 p., maps, illus., tables, biblio. Price $2.00.

A knowledge of the marine benthos available as a food supply for such arctic mammals, birds and fishes as the walrus, bearded seal, eider duck and rock cod is needed for the efficient management of these species. This study analyses the distribution and abundance of marine soft-bottom benthos in north Baffin Island, west Greenland and northwest Foxe Basin. Following a brief description of field equipment, collecting techniques and location of the sampling stations, the species composition of the benthos samples is listed. This data is combined in tabular form with data on the mean numbers and the weight per square metre for each species in the samples to provide an estimate of the standing crop.

In the second part of the paper a discussion of the reliability of the data is followed by a description of the environmental conditions under which species communities are found, and of the factors that affect the composition and crop of arctic benthos available in an area. These factors include periodic population fluctuations, changing environmental conditions, sea-bottom characteristics and variable oceanographic conditions. The paper concludes with a brief comment on the productivity of the marine level-bottom benthos.

[V.W.S.]

The Relationship of the Peary and Barren Ground Caribou. T. H. Manning. *Arctic Inst. North America*, Tech. Paper no. 4; Montreal, 1960. 52 p., tables, figures. Price $2.00.

The relationships of four main caribou population groups are considered in this paper: the Queen Elizabeth Islands population; the Banks Island population; the Dolphin and Union herd (which formerly summered on Victoria Island after crossing the Dolphin and Union Strait from the mainland); and the mainland population. A comparison of skins, antler velvet, hooves, and skulls from museum specimens and other collections follows a brief summary of previous knowledge. These results are discussed, conclusions drawn, and a reconstruction of the origin of the Peary caribou and its intergrades is attempted.

[P.L.H.]

THE BIRDS OF WEST-CENTRAL ELLESMERE ISLAND AND ADJACENT AREAS. D. F. Parmalee, and S. D. MacDonald. Dept. Northern Aff. National Res., Ottawa, 1960, *National Mus.* Bull. no. 169. 103 p., illus. Price $1.50.

In this ornithology, 23 species of birds found on west-central Ellesmere Island are considered. A short introduction contains summaries of the topography, climate, vegetation, faunal investigations, previous ornithological work, and a brief outline of the taxonomy and methods used. The species are each considered under the following main sub-headings: arrival, nesting, departure, specimens, and annual breeding cycle, with additional notes on banding, roosting, food, and predation. The nine photographs illustrate the birds and their habitats, and the terrain.

[P.L.H.]

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